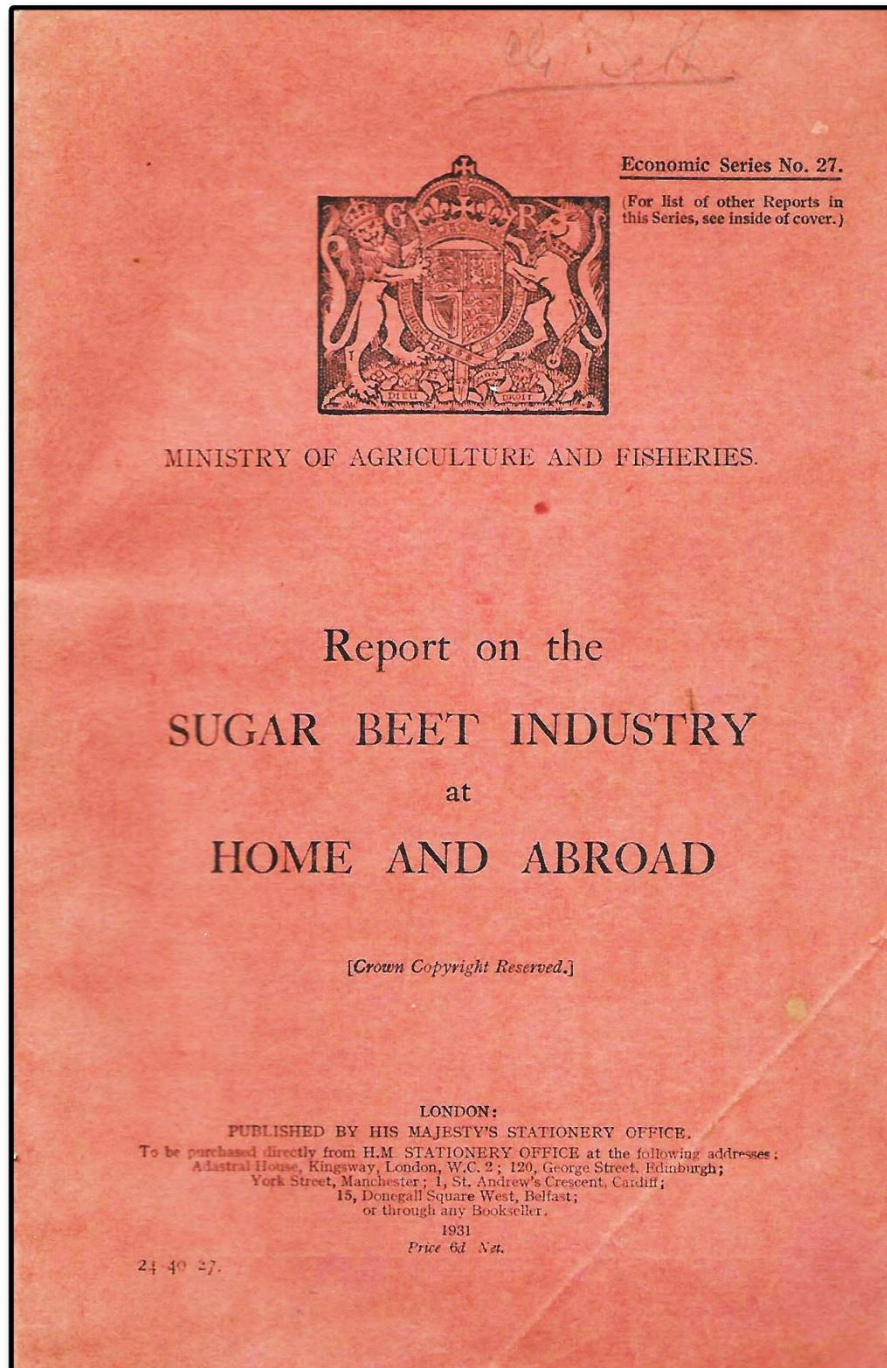


The following pages are extracts from the below publication by the Ministry of Agriculture and Fisheries, 1931, Report on the Sugar Beet Industry at Home and Abroad.



History of the Home-Grown Sugar Industry. Early Enterprise. --As far back as the beginning of the 19th century, the progress made on the continent in the production of beet sugar led to experiments in sugar beet cultivation and beet sugar manufacture in the United Kingdom. A small factory was erected about 1832, at Ulting, near Maldon, Essex, by Marriage, Reid and Marriage, and in 1850, a second factory was erected at Mount Mellick, Queens County, Ireland. Both these early enterprises failed owing to financial and technical difficulties and the inexperience of growers.

In 1868, James Duncan, a refiner of imported raw sugar, erected a small factory at Lavenham, Suffolk, for the extraction of beet juice in a concentrated form, completing the operations of crystallisation at his London refinery. The factory was built to deal with a total of 20,000 tons of beets per annum, but secured only 8,000 tons for its first and only beet campaign. The price of 20 shillings per ton paid to the beet growers was not sufficient, since it was not then known whether the climate and soil in this country were suitable for the crop. At that time, the average sugar content of the beets was only about 9 percent and difficulties in regard to effluent disposal also arose. In 1884, the factory passed into the hands of a company, which hoped to clarify and refine beet juice with Strontia, (strontium oxide, a white solid resembling quicklime), but after a few weeks the effort was abandoned.

Despite these failures, experiments in sugar beet cultivation continued in various parts of the country, particularly in Norfolk, Suffolk, Lincolnshire and Kent. From 1901 onwards, the scope of these efforts was widened through the untiring advocacy of the Earl of Denbigh. Better-organised educational efforts followed, chiefly by the Central Chamber of Agriculture and its offshoot, the Sugar Beet Council, the National Sugar Beet Association, the Incorporated English Beet Sugar Pioneer Association of Liverpool, and the Department of Agriculture of Cambridge University. The experiments carried out proved that sugar beet of a satisfactory quality could be grown in England, and eventually forced on the attention of the Government the possibilities of this new agricultural enterprise. The Board of Agriculture and Fisheries, in reporting on experiments arranged in 1911 at 7 centres in England, stated that there is no question that beet with a high sugar-content can be grown in this country and give yields equalling if not exceeding, those obtained on the Continent.

Efforts to Establish Factories. From 1909 onwards, several promising factory schemes were organised and carried through to various points of development, but not to fruition. The difficulty lay less with the farmer than with the investor. It was a period of reports, estimates, forecasts, provisional contracts with farmers and the circulation of draft prospectuses, --but not of factories. In the words of the Minister of Agriculture, who formally opened the Ely factory on October the 15th, 1925, "Disappointment followed quickly on the heels of hope," for, through failure to obtain capital from British investors, the schemes were abandoned. In 1909, for example, the Lincolnshire Beet Sugar Company, Limited, was formed to build at Sleaford, for £100,000, a factory with a capacity of 500 tons per day. Promises were made by 264 farmers to grow 1,980 acres of sugar beet for five years at 17 shillings and 6 pence per ton. Provisional contracts were made for the site, for the erection of the factory and for the machinery, but the company never went to allotment. The capital was not forthcoming.

In 1910, the East Anglian Sugar Company, Limited, with a view to establishing a factory at Malden in Essex, arranged for sugar beet to be grown by farmers in Essex, Suffolk, Norfolk and Lincolnshire. The roots were sent to various independent factories in the Netherlands pending the erection of the factory, which, however, did not materialise.

The Incorporated English Beet Sugar Pioneer Association of Liverpool interested itself in schemes for factories at Kidderminster in Worcestershire, and at Hayle in Cornwall. Beet Founders Limited, of Kidderminster, arranged for 350 farmers to grow sugar beet on 2,000 acres for five years, commencing in 1911, at 20 shillings per ton. This scheme, despite his being primarily agricultural, attracted the keen support of the local leaders of industry, and although at the time it did not materialise, the present Kidderminster factory, built in 1925 on the original site with the aid of about £80,000 capital provided by local manufacturers, was the result of the revival of the old interest under new conditions. Schemes were also elaborated for factories in Sussex (Ticehurst), Cheshire (Winsford) and Norfolk.

The promoters of some of these schemes sought the aid of the Development Commission appointed under the Development and Road Improvement Funds Act, 1909, but without success as the Commission had statutory authority to recommend advances only to bodies not trading for profit.

The failure of these attempts exposed the main difficulties in the way of the establishment of the sugar beet industry. The investor would not risk his capital in a beet sugar factory unless the raw material could be assured for a term of years at a price which left a definite margin to cover his risks. The farmer, on the other hand, would not undertake to grow the crop to the necessary extent and for the necessary period of years unless, in advance, he was assured of the factory as a market for his produce. Moreover, although the prevailing customs duty on imported sugar was 1 shilling and 10 pence per hundredweight, and no excise duty existed, there was every probability that a countervailing excise duty would be imposed, in accordance with the recognised fiscal policy of the time, in the event of a substantial quantity of home-grown sugar being produced.

Had it been possible before the War to have provided a subsidy as an incentive to education and enterprise, savings both to the consumer and to the Exchequer might have been achieved in the long run. The price of sugar to the consumer in those days was only 1 1/2 penny to 2 pence per pound, 14 shillings to 18 shillings per hundredweight, –including the customs duty of 1 shilling and 10 pence. When, during the War, Continental imports were entirely cut off, there was a serious shortage of sugar; prices soared to 1 shilling and two pence per pound, and the purchase of sugar and its distribution came under the control of the Royal Commission on Sugar Supply. The nation's sugar requirements had to be obtained from tropical cane-sugar producing countries, mainly Cuba and Mauritius. Ships that could not be spared were brought into requisition for its transport and many never reached their destination.

Prices remained high after the War; even in 1920 to 1921, sugar was sold at from 118 shillings to 120 shillings per hundredweight, (including duty at 25 shillings and 8 pence), or over 1 shilling per pound. In the autumn of 1921, the general slump in food prices took place, sugar falling to 40 shillings per hundredweight, or about four pence per pound. It should be remembered that every penny per pound variation in the price of sugar at the present rate of consumption in this country, namely 2,000,000 tons per annum, represents over £18 million per annum. United States experience is worth quoting in this connection: – “The beet sugar producers of the country have particularly agreed with the Food Administration to limit the price of sugar to a basis which should result in a reduction of about 1 1/2 cents per pound from the present price, affecting a saving of \$30 million to the consuming public between now and the 1st of next year. This patriotic action of the domestic sugar industry in acting as a control over the price demanded for imported sugar will not only make the saving mentioned above

between now and the end of the year, but will contribute largely to establish a low price for imported raw sugar throughout the year.”

(Herbert Hoover, 27th of August, 1917).

After the outbreak of War in 1914, the Institute for Research in Agricultural Economics, Oxford University, conducted for the Development Commission an exhaustive inquiry into the agricultural possibilities of the sugar beet industry, with special reference to the West of England. In the report on this inquiry, published in the Board of Agriculture's Journal (June, 1915), the Cornish proposal was sympathetically reviewed. This was significant, as it was the prevailing view that the prospects of success of the crop were confined to East Anglia.

The Cantley Factory. The first modern beet sugar factory in this country, –that at Cantley, in Norfolk, –was due to Dutch initiative. Foreign enterprise thus played an important part in the establishment of the sugar beet industry in this country in much the same way as, many years ago, valuable assistance was given in the establishment of our textile industry by Flemish weavers and to our agriculture by Dutchman who drained our fenland and left the name of Holland over part of Lincolnshire. Themselves sugar experts, the Dutch believed that as climatic and soil conditions in this country were similar to those in their own land, success should ultimately be possible. A scheme for a factory in Norfolk was initiated in 1910 by a leading Dutch sugar manufacturer and revived in the following year with the assistance of English colleagues and stronger foreign financial interests.

In 1912, the factory at Cantley was built, mainly with Dutch capital. The Anglo-Netherland Sugar Corporation, Limited, registered on December the 14th, 1911, was made possible by a pooling arrangement with a number of established Dutch factories. Of the £800,000 of share and loan capital, £170,000 was expended upon the factory and £575,000 was re-invested in shares and debentures in the Dutch allied companies. This arrangement enabled the company to set-off to some extent, by means of dividends, interest and guarantees, its development expenditure and initial losses. The factory was operated for four campaigns, 1912 to 1915, at a loss, although the company succeeded in securing a sufficient acreage of beets to provide for manufacturing seasons of modest dimensions. The company was wound up in 1916 and the undertaking, excluding the foreign assets, was acquired by the First English Beet Sugar Corporation, Limited, a company comprising a new English group, along with the leading members of the former Dutch group. The new company did not reopen the factory until 1920. It maintained the assets at considerable cost, pending more favourable conditions.

The first Government Grant to the Industry. In 1913, a group of eight English agriculturists, registered as the Sugar Beet Growers Society, obtained a grant, not to exceed £11,000, from the Development Fund in aid of an experiment in the cultivation of sugar beet. The grant was to apply only to that portion of the expenditure which, in the opinion of the Development Commissioners and the Treasury, could be regarded as promoting education and organisation. The Society hired land from farmers in Norfolk and Suffolk, paying them a hiring fee which included the preliminary cultivations in addition to the rent of the land, provided sugar beet seed and fertilisers, and imported labour from abroad, mainly from the Netherlands and Belgium, for the seasonal operations of singling, hoeing and harvesting. The roots produced were sold to the Cantley factory at the prevailing contract price of 22 shillings per ton clean weight, delivered at the factory.

The experiment comprised 2,994 acres from which 22,157 tons of clean beets were delivered, representing an average yield per acre of 7.4 tons, worth £8 2 shillings, and 10 pence. The cost of transport was 5 shillings per ton, or 37 shillings per acre. The cost of growing was £17 seventeen shillings and five pence per acre, 48 shillings 3 pence per ton, of which £8 seven shillings and threepence was paid to the farmers for the hire of their land and for the preliminary cultivations, £4 and 12 shillings per acre for seed and fertilisers, and £4 18 shillings and two pence for the labour for the seasonal operations. Even allowing for the Government grant, there was therefore a heavy loss; the experiment was not repeated, and the Society was wound up.

The object of the experiment was to demonstrate foreign methods of cultivation of the crop to farmers and to provide an additional quantity of raw material for the factory. Its fundamental disadvantage lay in the fact that the farmer did not share responsibility for the results, since he received his hiring fee whether the crop was successful or not. An experiment on similar lines, carried out directly by a factory during the earlier subsidy period, with a view to increasing its tonnage of beet, met with a similar lack of success and was not repeated.

The British Sugar Beet Society. In 1915 an association of prominent agriculturists, and public men, known to this day as the British Sugar Beet Society, was formed to undertake an entirely new investigation of the possibilities of the sugar beet industry in this country. The Society came to the conclusion that the main essential to the development of the industry was to secure capital for a factory in which both the private investor and the State should take a partnership risk.

A scheme was prepared for the acquisition of a large estate, upon which a factory was to be built and on which sufficient sugar beet should be grown to furnish the raw material for a manufacturing season of the minimum length consistent with economy. The estate would also serve to demonstrate to surrounding farmers the suitability of sugar beet as a cleaning crop in arable farming and the value of the by-products, –the crowns, and leaves and the dried pulp from the factory, –in increasing the stock-carrying capacity of the farm. The acquisition of a large estate at Kelham, in Nottinghamshire, was contemplated for the purpose of such an experiment, and the Society applied to the Development Commissioners for a grant to assist in putting the scheme into effect.

The Selborne Committee. The views of the British sugar beet Society were endorsed by the Agricultural Policy Subcommittee of the Reconstruction Committee, generally known as the Selborne Committee, in its Report presented in January, 1917.

The Selborne Committee, in its Report, expressed the view that the introduction of the sugar beet industry would be a contribution of much importance to the increased production of food-stuffs in the United Kingdom. The main questions to be settled before the industry could be established necessitated an experiment on a commercial scale and the scheme worked out by the British Sugar Beet Society was favourably referred to. The Committee urged the Government to arrange, without delay, for a complete test of this kind. The type of Government assistance favoured by the Committee was that of sharing or guaranteeing any loss up to a specified amount that might be sustained by the body undertaking the experiment.

The Kelham Factory. In March 1917, the Treasury, on the recommendation of the Development Commissioners, sanctioned an advance to the Society of £125,000, (subsequently increased to £131,125), by way of loan from the Development Fund for the

purchase of the Kelham Estate, in Nottinghamshire, of 5,603 acres, secured by mortgage on the Estate, which was "to be held in trust for the purpose of a sugar beet scheme and subject to their Lordships' directions." In 1918, a further loan of £40,000 was made from the Development Fund for the working capital of the estate, the management of which was vested in a committee, appointed by the Board of Agriculture, consisting of 6 persons, of whom 4 were members of the Society's Committee. Pending the Government's decision in respect of the Society's main scheme, the estate was devoted to the production of food-stuffs while being prepared for the cultivation of sugar beet when the War ceased, a policy continued by the Committee until the estate left its hands in 1920. In 1919, 2,769 acres of the estate were taken over by the Board of Agriculture for the settlement of ex-soldiers and ex-sailors upon the land under the Smallholdings Colonies Acts, 1916 to 1918, the purchase price of £47,750 being applied towards the repayment of the Development Fund loan. From the beginning, the Kelham farms have paid their way; since the introduction of sugar beet into the rotation, the yield of the corn crops has substantially increased, while the reserve of beet at its command has afforded considerable assistance to the Kelham factory.

During the three years, 1917 to 1919, the Society awaited a decision from the Government with regard to its factory scheme, the proposed capital of which was £500,000. The Government had been asked to provide half this sum and to guarantee for a period of 10 years a dividend of 5 percent on the remainder, which it was proposed to raise by public subscription. The capital so provided would suffice for the erection of the factory and for the working capital, and, in addition, for a sufficient sum to repay the Development Fund loans and thus enable the Kelham estate to be taken over from the control of the Board of Agriculture. Any profits made by the Committee in working the estate would accrue to the advantage of the main scheme.

It is important to recall a letter from the Board of Agriculture to the Society on July the 11th, 1918, in which it was stated that it was the declared policy of the Board of Agriculture to proceed with a thorough commercial test of the possibilities of the growth and manufacture of sugar in England, and to that end they had been parties to the purchase and present development of the Kelham Estate. The Board hoped still to have the cooperation of the British Sugar Beet Society in the raising of capital for the enterprise; –but should the Society find it impossible to raise from the public sufficient capital to prosecute, the enterprise, –would still feel bound to endeavour to carry out the erection of the factory and the manufacture of sugar as an experiment on the part of the State.

This made it clear that it was the intention of the Government to proceed with the commercial test recommended by the Selborne Committee, whether the private investor was willing to participate in the scheme or not.

On February the 26th, 1919, the Society was informed through the Board of Agriculture that the Treasury had accepted the Society scheme in principle. This decision was followed by the adoption by Parliament of the policy of Empire Preference in the Finance Act of the same year, indicating the attitude which was being taken towards the production of sugar within the British Empire.

There was already in existence, though not in operation, the factory at Cantley. Having regard to the increasing costs of materials and labour, the Society considered an offer of an option to purchase the Cantley factory for £165,000 on the ground that this might enable the Society to anticipate by one year its first manufacturing season and so reap the benefit of the high sugar

prices prevailing, namely, 118 shillings to 120 shillings per hundredweight, as well as the advantage of the Imperial Preference. Though independent reports by Continental experts on the Cantley factory were favourable, it was ultimately decided to build a new factory, as only on this basis would the Government assistance be afforded. In consequence, the English Beet Sugar Corporation, Limited, opened its factory in 1920 on its own account. The Cantley factory thus resumed operations for one manufacturing season before the Kelham factory was built.

It was among the conditions attached by the Government on its sanction of the Society's scheme that a separate company should be incorporated for the purpose, and that the subscription of one-fourth of the company's capital, £125,000, should be guaranteed by the Society's members, "in order that the Government could justify its own contribution of capital on the ground that the management would be in the hands of individuals with a substantial interest in the success of the enterprise."

Home Grown Sugar, Limited, was formed in February 1920. Of the £125,000 capital still required, half was taken up by the general public and the remaining half thrown back upon the underwriters, notwithstanding the fact that for 10 years, –up to March the 31st, 1930, the Government shares did not rank for dividend and that on the remaining shares, the Government had guaranteed a dividend at the rate of 5 percent for the same period. Under the Articles of Association approved by the Government, the management was vested in the public shareholders; the Minister of Agriculture as holder of the Government shares had no vote except on a special resolution or on a winding up. The Minister had the right, however, to appoint a director as the financial representative of the Government with powers of veto upon capital expenditure and appropriations to and from any Reserve Fund.

Dividends were limited to 5 percent so long as the Minister held shares or profit notes, – securities for repayment out of future profits of any sums paid by the Treasury to meet the Government guarantee. The Minister, who was not entitled to transfer any of his shares at his own discretion, was bound to do so at the call of the Board of Directors if the shares were paid for at par with interest at the rate of 5 percent from the date of allotment to the date of transfer. No such call has yet been made. The interest due on the Government shares to the 31st of March, 1930, if such a call were made, would be 4 shillings and 9 pence per share, or £59,375. All profit notes for guaranteed dividend have been repaid with interest, £40,083 in all. The company acquired the Kelham Estate and farming assets, at an independent valuation, from the British Sugar Beet Society, which with the purchase money repaid in full the Development Fund loans, together with an original guarantee fund of £10,000, leaving a sum of £14,677 which it handed over to the company. The Society remained in being and a new guarantee fund of £10,000 was raised.

The Kelham factory, the machinery for which was obtained from France, was not ready for operation until November, 1921. The total cost, owing to inflation in the prices of materials and labour, was £500,000 instead of the prospectus estimate of £300,000. Mortgages of £200,000 were raised to cover the extra cost, £75,000 from private sources, and a second mortgage of £125,000 from the Government. In fact, the inflated cost of buildings and machinery was a main source of financial trouble, and as is usual in such circumstances, handicapped the company for years afterwards. As the first manufacturing season progressed, it was found that the losses being incurred had already depleted the small working capital which still remained. The net deficiency to the 31st of March, 1922 was £103,509. It was clear to the director's that unless further financial assistance could be obtained, the company would be unable to meet

its engagements to the growers, while it was doubtful whether a new beet contract could be offered for 1922.

The directors therefore applied to the Ministry of Agriculture, (a), for power to raise the sum of £200,000 on second mortgage, ranking before the second mortgage of £125,000 then held by the Government, and (b), for a complete remission of the Excise duty on home-grown sugar, or at least its reduction to a nominal sum, or alternatively, a subsidy or bounty equal to the amount of duty paid. The Treasury agreed to allow the company to raise from the bank alone of £40,000 (guaranteed by the Chairman) to rank before its existing mortgage, but on the recommendation of a Committee of Enquiry appointed by the Minister of Agriculture to examine the financial position and prospects of the company, power to raise the second mortgage of £200,000 was refused.

Remission of the Excise Duty. In January, 1922, the English Beet Sugar Corporation had also advised the Ministry of Agriculture that it was bound to close its factory permanently unless the Excise duty could be remitted. The British Sugar Beet Society now concentrated upon the question of remission of duty, for which in February, 1922, application was made to the Prime Minister. This application was supported not only by Home Grown Sugar, Limited, and the English Beet Sugar Corporation, Limited, but by the Agricultural Committee of the House of Commons, the National Farmers Union and other agricultural bodies.

On March the 30th, 1922, the Minister of Agriculture announced the Government's decision, in view of the exceptional circumstances of the new industry and the unemployment in this country, to provide in the Finance Bill of that Session for the removal of the existing Excise duty. He further stated that in view of the fact that the remission of Excise was intended to assist a new industry during the experimental period, it might be hoped that Parliament would not re-impose any Excise duty until the industry had become firmly established. This announcement, in order to enable growers to plant their beet, anticipated the Budget statement of the Chancellor of the Exchequer. In 1922, the Customs duty was 25 shillings and 8 pence on foreign sugars, 21 shillings and four and two third pence on Empire sugars, and the Excise duty was 19 shillings, 5 and a third pence. The advantage which the home product henceforth enjoyed over foreign sugar was therefore 25 shillings and 8 pence per hundredweight, instead of 6 shillings and two and two thirds' pence.

The assistance thus given did not enable the two pioneer factories to secure new capital to pay off their pressing liabilities, and thus a proposed amalgamation did not materialise. The Kelham factory remained idle in 1922, but the Company was able to offer contracts on the guarantee of the Cantley company, which undertook to accept and work the beets along with its own, with the aid of further foreign financial assistance. In 1922, for the first time in this country, a beet sugar factory was operated at a profit. This the Cantley Company was enabled to do, not solely by reason of the remission of Excise duty, but through being able to work a full campaign with the combined beet supplies of Cantley and Kelham. In 1923, each of these pioneer factories worked at a profit, the acreage of beet having been doubled and remission of Excise duty having been maintained for a further year.

In the meantime, with the approval of the Minister of Agriculture, Home Grown Sugar, Limited, was reconstructed. The factory and other assets were written down to an independent valuation and the 500,000 shares of £1 each were reduced to five shillings each. The Government's guarantee of dividend was automatically reduced by three-fourths. In 1923, an arrangement was made with the Cantley Company to work the Kelham factory under a

partnership agreement, by which each company received a half-share of the profits, while the Cantley Company provided the working capital, and took responsibility for all losses, –an agreement which has twice been renewed and continues in force to the 31st of March, 1934, though both profits and losses are now shared in the proportions of two-thirds by Home Grown Sugar, Limited, and one-third by the English Beet Sugar Corporation. At the same time money was advanced by the Cantley Company and by the Chairman and one other Director of the Kelham Company for the alteration, and improvement of the factory, which was increased in capacity.

The British Sugar (Subsidy) Act, 1925. The sugar beet industry in this country was enabled to survive by the remission of Excise duty, but, as was emphasised by the British Sugar Beet Society in a statement addressed to the Prime Minister in March, 1924, further development was hindered by the uncertain nature of Government action each year with respect to the import duty on which the value of the remission of Excise entirely depended.

It was recognised that the rate of customs duty of 25 shillings and 8 pence per hundredweight, or two- and three-quarter pence per pound, could not be maintained when this country settled down to more normal conditions, and that the taxation of the 2 million tons of sugar consumed in this country at a rate necessary to give the required assistance to the comparatively small quantity produced at home could not be justified. The Society therefore approached the Government urging that assistance to the sugar beet industry should be guaranteed by the State for a definite term of years. On the assumption that the Excise duty would not be reimposed, this would involve the payment of a subsidy to the industry in the event of the import duty in any year being less than the assistance guaranteed. The Society had in mind that the guaranteed rate of assistance should start at 20 shillings or 21 shillings per hundredweight, and should be reduced annually on an easy scale, the opinion being held that, as experience was gained, both farmer and factory would naturally develop a technical efficiency that would off-set the effect of each year's reduction in the amount of State assistance.

The proposal of the Society was supported by the factory companies, representatives of agricultural interests and the organisations of Empire producers and sugar machinery manufacturers. The British refiners, on the other hand, who are being hard hit by imports of white sugar and who saw in the home-grown sugar industry a further rival, while not objecting in principle to the development of the industry in the interests of agriculture, maintained that a condition should be imposed that raw sugar only should be produced by the factories. This limitation the sugar beet industry was not prepared to accept, on the grounds that complete freedom should be given to all factories to make white or raw sugar according to their conviction as to which was the more economic course, and that they should have complete freedom in the marketing of their products.

The Finance Act of 1924 reduced the Custom duty on sugar from 25 shillings and 8 pence to 11 shillings and 8 pence per hundredweight. The Excise duty was not reimposed, so that there was still an indirect subsidy to the industry of 11 shillings and 8 pence per hundredweight. It was clear, however, even though the sugar price was much higher than at present, that under these conditions one, at least, of the factories could not carry on successfully; moreover, on the strength of the remission of Excise duty being continued, a third factory was in process of erection by the Anglo-Scottish Beet Sugar Corporation, Limited, at Colwick, in Nottinghamshire, for operation in the 1924 season.

The Government's decision, after exhaustive inquiry, was to provide a subsidy for the industry while at the same time re-imposing the Excise duty at the preferential rate applicable to imported Empire sugars. The British Sugar (Subsidy) Act, passed in March, 1925, granted a subsidy on home-grown sugar for 10 years, from and including the 1924 to 1925 season at the rate of 19 shillings and 6 pence per hundredweight. of sugar produced for the first 4 years, 13 shillings per hundredweight for the next 3 years and six shillings and 6 pence per hundredweight for the remaining 3 years. The minimum beet price to be paid to farmers for the first 4 years was fixed at 44 shillings per ton of beet at 15 and a half percent sugar-content. The Act also retrospectively imposed the Excise duty on home-grown sugar manufactured in the 1924 to 1925 season.

Immediately after this announcement, the controlling interests of the Cantley and Colwick companies, now known as the Anglo-Dutch and Anglo-Scottish groups, confirmed their assurance to the Government that they would each build 2 new factories to be ready for the 1925 season, with another factory to be built later. Subsequently, the principal sugar refiners decided to take part in the industry on substantial lines.

Effect of the subsidy. –The following facts will suffice to illustrate the development of the industry since the passing of the Subsidy Act. Whereas 16,000 acres of sugar beet were grown in 1923, 349,000 acres were grown in 1930 by no less than 40,400 growers. While only two factories were in existence in 1923, 18 factories were operating in 1930. The production of sugar increased from 13,000 tons in 1923 to 290,000 tons in 1929, and to 420,000 tons in 1930. In 1922, the price paid for beet was 38 shillings per ton delivered, while in 1930 the average price was about 50 shillings per ton. The number of workers in the factories has increased from 1,159 in 1923 to 9,900 in 1930, and it is estimated that about 30,000 casual workers found employment in 1930 in the sugar beet fields.

Sugar Beet Cultivation and Harvesting. The Sugar Beet. The sugar beet is usually long, similar in shape and colour to a parsnip, and with heavy, upstanding foliage. In contrast to the Mangold, to which it is closely related, the root grows almost entirely below the surface of the soil. Its long tap-root, penetrating, to a depth of three feet or more, together with its extensive system of rootlets makes the sugar beet a valuable plant for aerating and pulverising the soil. Normally, the plant is biennial, –i.e. producing seed in the second year, –but it occasionally shows a tendency to “bolt” or develop seed in the first year, a phenomenon believed to be encouraged by drought or cold weather retarding germination and early growth. The root averages about 1 LB in weight when cleaned and topped, and its sugar-content ranges from 13 percent to 20 percent, a great advance over the original sugar-content of the roots used by Achard.

Climate. It was originally believed that the climate of England, even in the east and south, was unsuitable for the plant, since long periods of bright sunshine were regarded as essential to the production of sugar. Nowadays, however, it is generally believed that the production of sugar takes place almost as well in diffused light, i.e. under cloudy conditions, –as in bright sunlight; the main requirement is day-light. This country, in fact, possesses an advantage in respect of climate, in that the autumns are prolonged, giving a longer period of growth and permitting farm and factory operations to be continued longer than on the Continent or in the United States, where the winters are more rigorous.

Soil. The most suitable type of soil for sugar beet is a deep, friable loam, which is free from stones and permits the preparation of a good seed bed, without being so light as to suffer from

drought or heavy enough to make lifting too expensive. In England, beet can be grown successfully on a wide variety of soils, provided they are not shallow.

The Place of Sugar Beet on the Farm. The introduction of roots into the economy of the farm about the middle of the 18th century was an important factor in the “agricultural revolution” which began about that time. Its most important effect was to provide a crop, the cultivation of which enabled the land to be cleaned and to a large extent replace the frequent bare-fallowing previously practised; at the same time, it provided a feeding-stuff which enabled a larger head of stock to be carried. In this country, when root crops were first introduced, the crop employed was the turnip, and later the mangold; on the Continent, where the root shift in the rotation was much slower in taking hold, the sugar beet was largely employed. The advantage of this crop was that the root provided an immediate cash return, whilst the leaves and crowns, together with the dried or wet pulp returned by the factory, provided food for cattle. At the same time, the deep-rooting habit of the sugar beet and the intensive cultivation and manuring required made it an excellent crop for improving the land. At present, sugar beet is regarded, wherever it is cultivated, as one of the most important factors in maintaining the general level of efficiency in agriculture.

It is generally agreed that, under suitable conditions, the sugar beet crop might very largely, if not entirely, replace turnips, mangolds and swedes in the farming system of this country, without prejudice to the stock-carrying capacity of the farm. In some instances, in the East of England, this has actually occurred on typical stock and barley producing land and has made possible an increase in the head of stock maintained. In the beet-growing areas of the Continent, silage made from the crowns and leaves of beet, together with the pulp returned by the factory, is, during the winter, the principle bulky food for stock, especially fattening cattle and dairy cows, on farms in vicinity of the beet sugar factories.

Sugar beet does well after cereals and potatoes, spring cabbage, folded roots and seeds. The following crop is usually a winter or spring cereal. Beet makes an excellent preparatory crop for barley and for winter wheat if it can be lifted early enough, while potatoes or any crop requiring a deep tilth also do well after it. The crop can be successfully grown several years in succession on the same land, but this is not to be recommended as it renders the crop liable to disease; in Germany and the United States, in fact, large areas have become “beet sick” through infestation by nematode (eel-worm) as a result of this practice.

Manurial Treatment. The manurial treatment of sugar beet has been the subject of much research, both in this country and abroad. Where beet is the only root crop, practically all the manures, particularly the organic manures, should be applied to it, the surrounding crops requiring little or no manurial treatment. The sugar beet requires relatively large quantities of potash and nitrogen, and moderate quantities of phosphoric acid. Nitrogen stimulates the leaf growth. Potash is closely associated with the formation of sugar and is particularly necessary on Fen soils where the application of artificial nitrogenous manures is generally unnecessary. Phosphates are essential on sandy and very light soils. Successful beet growers are invariably heavy users of manure.

Preliminary Cultivation. The cultivation of sugar beet is similar to that of mangolds, the main essentials being a deep tilth and a good seed bed. Ploughing to a depth of 12 inches (or more, if possible, without bringing up too much raw subsoil) is recommended; the roots must be given every opportunity of going deep. All deep ploughing should be done as early as possible in winter to enable frost to exercise the maximum disintegration effect. If a “pan” is present, it

may be advisable to use a subsoiler. Spring cultivations are mainly concerned with the preparation of the seed bed, (for which a good tilth is essential) by the judicious use of the cultivator, harrow and roller. Rolling both before and after drilling is important, especially on light land, to consolidate the surface and promote the upward movement of moisture from the subsoil. Skilful preparation of the seed bed and the drilling of seed to a uniform depth promote rapid and even germination; this is most important in obtaining the even stand which is essential to a good yield. Indifferent cultivation results in badly shaped and “fangy” beets.

Seed and seeding. In this country, the factories recommend drilling at least 15 lbs of seed per acre, and it is generally agreed that more could be used with advantage. Seed is cheap, and a generous seeding, if it ensures a full and even stand, represents money well spent. On the Continent, much heavier seeding is common, 25 to 30 LB per acre being not unusual. Generally, the earlier the sowing, the greater is the quantity of seed required. More seed is also required where there is a poor tilth.

Drilling. Drilling usually takes place from mid-April to mid-May. Early seeding is usual as it allows time for re-drilling should damage befall the first sowings, but if the weather be very cold or dry, it is better to delay the work in order to avoid detrimental checks to germination and early growth.

Growers with a large acreage usually sow their land in succession at intervals of from 10 to 14 days, as this enables the subsequent cultivations to be spread over a longer period and eases the organisation of labour. Further, as all the beets do not ripen at the same time, the maximum sugar-content is maintained at the time of delivery, which is carried out at regular intervals during the season from October the 1st to December the 31st.

Special machines are made for drilling beet seed, the most suitable for this country being those which drill four rows and are adjustable for width of row, but mangold or corn drills can be used provided they can be adjusted to the required width.

Singling. Singling is one of the most important operations in sugar beet growing, and should, in consequence, be very closely supervised. It usually commences as soon as the plants show four secondary leaves.

Delay in singling may affect the yield by two or three tons besides involving additional labour. Singling, which requires a good deal of skill, consists of two operations; first, the isolation of bunches of plants by chopping out all intermediate plants with a hoe, and secondly, the singling of the strongest plant in each bunch, -- an operation which is best done by hand to avoid damage to the plants. It is becoming a common practice in this country to perform both operations at the same time with the hoe.

Where the drills are 18 inches apart, from 24 to 27 plants should be left to every 20 inches of row; even spacing is important.

Importance of Optimum Plant Population per Acre. The distances between the plants most commonly advocated in Great Britain are 20 inches by 8 inches, 18 inches by 9 inches and 16 inches by 10 inches. All of these have their supporters but all, theoretically, should give the same stand, namely 40,000 plants to the acre.

Hoeing. Constant hoeing is essential during the growing period to aerate the soil, destroy weeds, and prevent excessive evaporation of soil moisture. Hoeing in the rows is done by machine, and between the plants, usually by hand.



FIG. 15.—Singling.

Horse hoes should be at work as soon as the plants appear, and in the early work. It is advisable to use an implement provided with discs to prevent the young plants from being covered with soil.



FIG. 16.—Hoeing.

Later work aims at keeping the soil up to the roots. Hoeing should be continued until the leaves meet across the rows and thus smother weed growth; it should be deeper as the season progresses, the last hoeing being as much as from 2 inches, to 3 inches in depth in order to maintain a mellow surface up to lifting time. Careless hoeing is likely to result in loss of beet plants with adverse effects on the yield per acre.

Diseases and Pests. Sugar beet is attacked by a large number of diseases, few of which, however, are of great economic importance. Up to the present, beet has not suffered greatly in this country from disease. If the practice of growing the crop on the same land in successive years is avoided, the risk of attack is reduced. The principal diseases and pests of sugar beet are given below.

Fungi. Root Blight, *Phoma betae*, Leaf Brown, Mildew, Leaf Spot.

Pests. Beet Fly, Springtails, Nematode, Black Aphids, Wireworm, The Pigmy Mangold Beetle.

Harvesting. Ripeness in sugar beet is indicated by drooping and yellowing of the outer leaves. Harvesting may commence when about three-quarters of the foliage has wilted, the central leaves remaining fresh. The time of harvesting varies considerably with climate. In this country, lifting may commence in the last week or so of September and may continue right up to the end of January. The beets in this country are usually lifted with special lifting machines. The

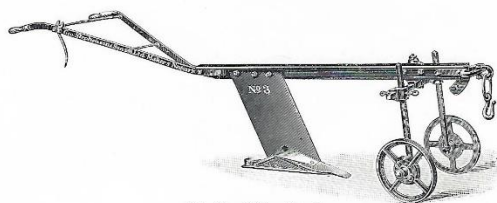


FIG. 17.—Lifting Plough.

most common type, (Figure 17), is one which, running between the rows, loosens the beets in the soil so that they can be easily pulled up by hand. When pulled, the beets are roughly cleaned by knocking together and then "topped" —i.e. the crown is cut off with a heavy chopper or sickle-shaped knife squarely below the commencement of the lower leaves. If topping is not properly

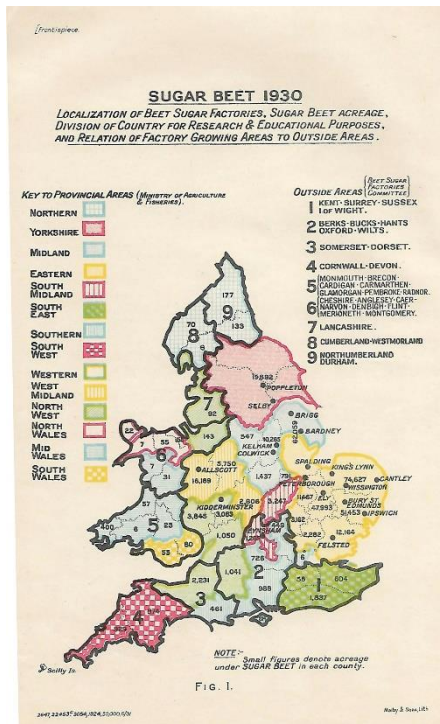
carried out on the field, not only will the grower incur unnecessary freight charges, but the sample of his consignment taken for tare deduction will be re-topped at the factory. After topping, the beets are thrown into heaps and carted from the field, either direct to the factory, to the station, or to dumps for later transport. If they are not to be carted the same day, the covering of the heaps with tops will prevent possible injury by frost or the action of the sun. Beets do not suffer from moderate frost before lifting.

Clamping. Owing to the congestion that would occur if all beets were sent in at the same time, the factories require deliveries to be spread evenly throughout the campaign. It is, therefore, rarely possible, except in the case of small growers, to dispatch the whole crop at once, and if a grower wishes to clear his ground, or if hard frost is to be feared, it is usually better, on lifting the beets, to place them in “clamps” to wait delivery. Clamps are usually long heaps, triangular in section with a base width of approximately 5 feet. The beets are covered for protection, either with tops or with straw and earth. The results of trials conducted under the auspices of the Ministry of Agriculture and Fisheries appear to show that, if the clamps are properly constructed and the beets have been well topped, serious loss of sugar-content in clamp is unlikely within a normal storage period.

Field Labour. Labour Factor in Beet Cultivation. Labour is the main item of expenditure in beet production. Sugar beet is a crop particularly dependent for success on an adequate supply of efficient manual labour at the precise moment when it is wanted. The question of labour supply is especially urgent at singling time, when careless workmanship or delay will have a seriously adverse effect on the resultant yield. The singling of beet coincides with the singling of other root crops, and, as the introduction of beet has caused a considerable increase in the proportion of arable land under roots in the principal beet-growing areas, a demand is put on the labour supply which in some areas is met with difficulty. To a less extent, the same applies to harvesting time; in this case, however, the pressure on the labour supply is less, since to meet the convenience of the factory, the work must be spread over a longer period. A deficiency of labour at harvesting, however, not only upsets the whole labour organisation of the farm, but also the carefully organised system of even deliveries to the factory, while carelessness in topping and cleaning adds materially to the tare. Hand hoeing, while of great importance culturally, is less dependent on the time factor.

The regular farm staff on the larger holdings cannot usually cope with the abnormal periodic demand of the crop for labour, particularly in view of the general tendency to reduce the amount of labour employed on farms. In consequence, large numbers of casual workers must generally be engaged. Usually, the permanent staff of the farm undertakes only the earlier cultivations, –the manuring, the preparation of the seed bed and the seeding, –followed by horse-hoeing during the growing period. All the other seasonal operations, –e.g. singling, hand hoeing, lifting, topping, heaping and loading, –where the area under beet is considerable, involve the employment of casual workers. It is, therefore, on the skill and ready availability of this casual labour that the success of the crop largely depends. Root growing has formed an essential part of crop rotations in this country for many decades, and the regular farm labourer as well as many of the casual hands are, therefore, accustomed to the various cultural operations, though sugar beet probably demands a higher standard of skill than other root crops.

Distribution of Factories in relation to Beet Area.



The situation of the factories in relation to the sugar beet area is shown in the frontispiece. Of the 18 factories operating in 1930, 3 are in Norfolk, 3 in Lincolnshire, 2 each in Suffolk, Nottinghamshire and Yorkshire, and one each in Cambridgeshire, Worcestershire, Essex, Northamptonshire, Shropshire and Scotland, (Fifeshire).

A factory in Scotland, (Renfrewshire), was closed down at the end of 1927, and one at Eynsham in Oxfordshire in 1930

Loading machines. Motor-lorries are seldom able to enter the beet fields. Carts must be used to convey the beets to the dumps for loading on to lorries, or alternatively, the carts go direct to the railway station.

To reduce the work of transferring beets from carts to lorries, an automatic loader, (figure 29), has been tried and found very effective. This machine has the advantage of reducing the amount of dirt loaded with the beets.

An experiment carried out by the factories and growers with the automatic loader showed that in the loading of 2,000 tons of beets, 300 tons of dirt were removed on which carriage charges to the factory would otherwise have been incurred.

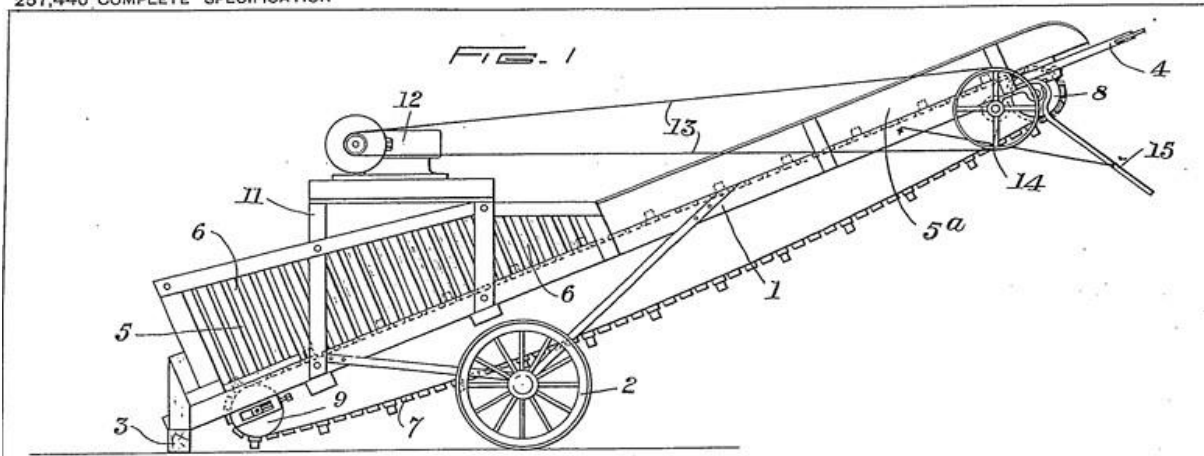
A cart-load of beet was delivered into the lorry, barge or truck in 1 1/2 minutes. A machine, which tops the beet and loads into carts in one operation, is also being investigated by the factories.



FIG. 29.—Mechanical Loading of Sugar Beet.

A Thomas Walter Hugh Clarke, of Denmark House, Ely, invention.
Patent number GB 257 440.

257,440 COMPLETE SPECIFICATION



Absence of Hard Roads in Fen areas. --In the Fen areas, the inadequacy of roads severely curtails the growing of beet on land eminently suited to the crop. An area of about 20,000 acres round Ely and Cambridge, for example, is practically useless to the beet industry owing to the absence of suitable means of communication. In places, only tracks or "droves" exist and no hard roads are to be found for several miles. One of the Fen factories receives no road-borne beet whatsoever and has to lease about 20 miles of privately owned, standard-gauge railway track, which it operates with 3 locomotives and 300 trucks.

The responsibility for improving these Fen droves rests theoretically with the landlords, although it is usually left to the local authority. The latter, however, is often overwhelmed with work on trunk roads, bridges and so forth, but the position generally is that if it puts forward a scheme, the Ministry of Transport may, in certain circumstances, be able to afford financial assistance. Alternatively, application may be made to the Unemployment Grants Committee, which has certain powers to allocate money for the improvement of unclassified roads.

Damage to Roads. --Beet traffic inevitably gives rise to considerable wear of roads in the factory areas, particularly of those in the neighbourhood of stations and factories. Most of the sugar beet crop has to be carried for a part of its journey by road at a time of the year when the roads are normally in the worst condition to withstand the damage. The majority of rural roads have no proper foundation and are little able to withstand heavy traffic, whilst short days and bad weather during the beet season retard the carrying out of repairs. In many instances, beet traffic has caused exceptional damage owing to the use of large traction engines with trailers, especially when fitted with iron-shod wheels. The fitting of rubber and, preferably, pneumatic tyres, where practicable, has mitigated the trouble.

Water Transport. --Where the farm or the factory is conveniently situated near waterways, the use of water transport has many advantages: In particular, it is comparatively cheap. If the beet field is adjacent to the waterways and the canal bank is high enough, a chute may be employed to load the roots direct into the barge. In less convenient circumstances, haulage and loading charges are incurred which reduce any advantage in cost. Unless the factory is situated on the water side, thus permitting of direct discharge by crane, water deliveries are the most difficult to handle at the factory, as the roots have to be unloaded into railway trucks or road vehicles in order to be taken into the factory. Thus, in one instance, where the waterway was some distance from the factory, delivery had to be completed by lorry at a cost of three shillings a ton. On the other hand, the use of canals should widen the area in which

beet can be grown economically. The eastern counties of England are well served with waterways, which might be brought into greater use if improvements were effected.

Factory owned Water Transport. --Those factories in the Fen areas which are conveniently situated for receiving water-borne beets generally own or hire tugs and barges for the purpose of beet transport. The rates charged by the factories to growers are either comparable with those charged by ordinary water transport companies, or more generally, are fixed on the basis of the actual cost. The conditions under which the grower may make use of these facilities are, --that the loading point must be easily accessible, that he undertakes his own loading, (though in certain cases he may utilise the services of the bargeman on payment), and that loading is completed within an allotted time, otherwise demurrage is chargeable or the barges are withdrawn. To the farmer who can comply with these conditions, this method of consigning to the factory is cheaper than other methods.

The Factory Sidings. --The bulky nature of the beet necessitates the devotion of a large area of the factory premises to railway sidings and road approaches. At one British factory, for instance, there are four and a quarter mile of track. Private sidings are maintained in conjunction with the railway company's main line, with which a section of the sidings is connected. The railway company's engines shunt the traffic onto this section, while the factory's locomotives take the traffic to and from the sidings connected with the beet flumes, the sugar store, the molasses tanks, the pulp store, and the coal and limestone dumps. During the 1929 season, 26,414 railway trucks passed through the sidings of one British factory alone. The private siding avoids unloading at the railway station and subsequent road transport to the factory, and, in effect, takes the place of a large railway goods station; the railway charges to the factory for transport are based on delivery to the private siding instead of to the railway station. This means that where the cost to the railway company of dealing with the traffic at or in connection with the private siding is less than the appropriate charge for dealing with the traffic at the terminal station, the factory gets the benefit of the difference. This difference is regarded by the factory as compensation for the provision, upkeep and working of its sidings.

Mechanical Unloading of Beet. --In this country, about 35 percent of the beet deliveries are unloaded by mechanical means, --either by crane grab or by wash-out plant or water gun of the "Elfa" type, --and the remaining 65 percent by hand. Many of the factories used the hand method entirely, others combine the two, while in one instance, the whole of the unloading is done mechanically. The advantages of the Elfa plant are speed of working and the fact that the beets are delivered directly into the factory.

Tare and Sugar-Content. --Beet Reception at the Factory. --On arrival at the factory, the vehicles are passed over a weighbridge to obtain the gross weight, samples being taken for the purpose of ascertaining tare and sugar-content. The beets are then unloaded into silos or flumes along-side the roadways, and railway lines, being either forked out of the trucks or washed out by a stream of water directed from an "Elfa" plant or water-gun. Truck-tipping devices are also occasionally used. The empty trucks, including the loose soil, are then reweighed to obtain, by deduction, the untared weight of beets delivered. In the case of barge traffic, the beets are unloaded by crane grab. The weights, gross and untared, are ascertained by calibration, (displacement), before and after unloading. Road vehicles are usually unloaded by the grower with assistance supplied by the factory, while rail vehicles and barges are in all cases unloaded by the factory.

Weighing, Sampling and Taring. --The methods of weighing, sampling, and taring of beet consignments adopted in this country, as well as the method of ascertainment of the sugar-content of the beets, are set out in the beet contract, and, up to 1931, were governed by

supplementary detailed arrangements made between the National Farmers' Union and the Beet Sugar Factories Committee of Great Britain in connection with the standard beet contract for the three years 1928 to 1930. The importance of standardising these methods is obvious in view of their bearing on the cash return to the grower.

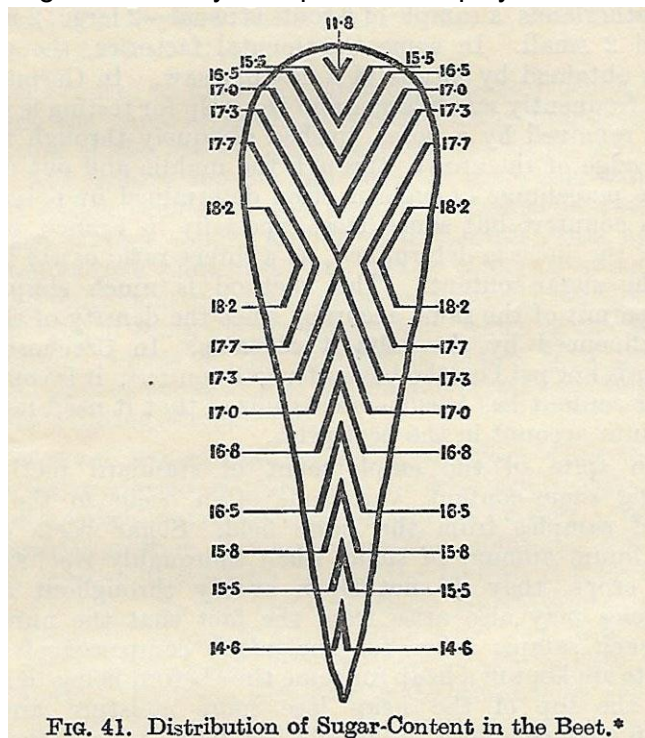
The standard methods employed in this country are, briefly, as follows. The weights of all vehicles at the factory, both before and after unloading are taken to the nearest 28 lbs. The factory is entitled to unload by water power or other mechanical means, or by hand. The former method is becoming more general. The methods of sampling for the determination of tare and sugar-content vary according to the method of unloading employed. They are as follows: – *Manual unloading.* –When the consignment has been unloaded sufficiently to enable the men unloading to stand on the floor of the vehicle, the sample container, capable of holding a little over 28 lbs, is filled by forking the beet from the floor in exactly the same way as the bulk is handled into the flume. *Unloading by tipping or by water power.* –A side or back door of the vehicle is dropped and a sufficient quantity of beet removed to allow a sample to be secured with a beet fork as nearly as practicable from the centre of the consignment. *Unloading by grabs.* Unless the sample is taken in the foregoing manner, the following method is applied: when sufficient beet has been removed to allow the teeth of the grab to touch the bottom of the vehicle or vessel, the sample-container is placed against the vertical or sloping surface of the beet, the sample being raked in with a beet fork from about the centre of the face exposed. One sample is taken from each 10 tons or part of 10 tons in each consignment. If more than one sample is so taken, the figures of the various samples are averaged for the purpose of arriving at tare and sugar-content. If the representative of the growers, or of the factory is of the opinion that any sample is unfair, he has the right to demand that another sample be taken, provided it is practicable before the consignment is completely discharged. This sample, now the “official” sample, is taken in the presence of representatives of both factory and grower.

To arrive at the tare per hundredweight, the sample is weighed exactly to 28 lbs. The beets are then washed in the tare house, and, if necessary, re topped squarely below where the lowest leaves have grown, and again weighed. That tare per hundredweight in pounds is calculated from the difference between the two weights. 2 lbs are then added to the tare if the consignment has been unloaded mechanically or by water power, or by tipping, to allow for loose dirt swept out of the vehicle. The tare is deducted from each hundred weight of the beets and soil weighed into the factory, and the net weight notified to the grower as the weight of his consignment to the nearest 28 lbs. The weight of the tops (if any) removed from the sample is separately recorded on the growers' advice note.

The method of washing samples has also been standardised; washing machines must have openings between the slats of the revolving drum of approximately 3/4 of an inch width, and the maximum speed of revolution of the drum must not exceed 25 revolutions per minute.

Proportion of Tare. --The average tare in consignments of beet to factories in Great Britain range from 13.5 lbs per hundredweight of washed beets in 1929 to 19.3 lbs in 1927. It is estimated that during the six years 1924 to 1929, 1,084,000 tons of earth were carried to the factories with the beets, upon which transport charges amounting to nearly £300,000 were paid by the farmers. The accumulation of Earth as a result of “tare” is an embarrassment to the factories.

Ascertainment of Sugar-Content. --The method of determining the sugar-content of beet is highly important to growers in this country because of the premium given for high sugar-content. It has been standardised on the basis of the results of experiments carried out in 1928 at the Department of Agriculture, University of Cambridge, at the request of the National Farmers Union and the Beet Sugar Factories Committee. After "taring", the beets in each sample are turned out onto a grading board, and 10 beets of different sizes, representing as nearly as practicable the range of sizes in the sample, are selected therefrom and tested for sugar-content by a responsible employee of the factory.



The method of analysis employed is the cold-water digestion method (as prescribed in the British Sugar (Subsidy) Act, 1925, for the years 1924 to 1927), that adopted being the "Sachs le Docte," which is specifically described in the beet contract (Appendix B). The pulp required for this method of analysis is obtained from the beets by means of a mechanical rasp. The rasp pulps a longitudinal wedge-shaped section out of the beet, which, as is shown in Figure 41, is necessary in order to take out a representative sample from the beet. Since 1929, the rasps have been purchased by the National Farmers' Union at the expense of the Beet Sugar

Factories Committee, a supply being held in the custody of the Union to be available for replacement purposes at such times as the factories require them. The rasps are rotated at a speed of from 300 to 350 revolutions per minute. A new rasp is fitted in the rasping machine for each 2,000 samples, and, as shown in figure 39, is worked with a clamping device with guides. The percentage of sugar is often determined by polarimeter.

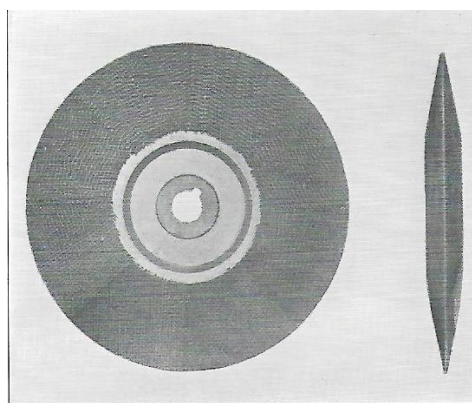


FIG. 38.—Rasp.

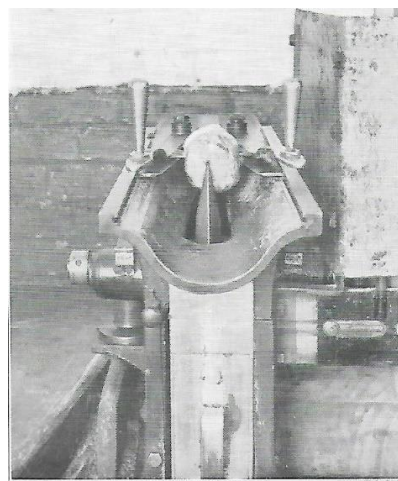


FIG. 39.—Rasp in operation, showing clamp with guides.

The methods of ascertaining the average sugar-content are very similar in principle in most beet-growing countries. In spite of the employment of standard methods of ascertaining sugar-content, variations often occur in the sugar-content of samples from the same field. Sugar beets contain their maximum amount of sugar when thoroughly ripe, and, like all other crops, they do not ripen evenly throughout a field. Discrepancies may also arise from the fact that the number of beets in each sample taken for analysis is comparatively small. When beets are kept in a heap for some time before being delivered, those on the top of the heap lose more moisture and thus increase in sugar-content relative to those within the heap. If in sampling two loads of beets of equal ripeness from the same field, the beets from the top of the heap should by chance get into one of the samples, a difference between the sugar-content of the two loads would naturally be shown.

Growers Representatives. The sampling of beets for both tare and sugar-content is, from time to time, the occasion for disagreement between individual growers and the factory. To protect their interests, growers in many countries maintain at their own expense a representative who checks the factory returns of sugar-content and tare. In this country, there are stationed, at every factory, growers' representatives appointed by the National Farmers Union, whose sole duty is to verify the weights, tare and sugar-content of the beets delivered as determined by the factory officials. The standardisation of practice greatly assists their work. This scheme was initiated in 1922 by the British Sugar Beet Society, which made the first appointment to the Cantley factory, from a list of persons nominated by the National Farmers Union. The cost of the representative to the Society was defrayed by the deduction by factories of 1 penny per ton of beets delivered from the accounts of the growers, unless they were members of the Society or the Union, when the deduction was only a halfpenny per ton. A similar procedure was followed in 1923. In that year, however, the deduction took the form of a grower's membership subscription to the Society of 1 1/2 penny per ton, of which one penny was applied to the maintenance of the representative and to meeting the cost of the Chartered Accountant appointed by the Society with the approval of the National Farmers Union to verify, on behalf of growers, the average sale price of sugar, on which in that year the beet price was for the first time based. In 1924, the Union took over full responsibility for the scheme. It was not until 1925 that the deduction by the factories from the growers' accounts of the levy of 1 penny per ton on behalf of the Union was provided for in the contract itself, but the practice had been accepted by growers with few exceptions. Under the beet contract, any group of farmers growing a total of 1,500 acres of beet for one factory was entitled to appoint its own representative. Any grower, if he wishes, can see his own consignment tested for tare and sugar-content at the factory.

Taring Superintendent. In 1929 and 1930, the Beet Sugar Factories Committee appointed an officer, called a Taring Superintendent, to visit each factory on behalf of all the factories, in order to ensure that the agreed standard practice as regards taring and ascertainment of sugar-content is maintained.

Beet Sugar Manufacture. General. The production of beet sugar is a highly scientific process, depending for its success on the chemical control of the material as it passes through the various stages of manufacture. Since the days of Archard, the technique of beet sugar manufacture has undergone frequent and drastic changes. The old rasps and presses, for example, formerly used for obtaining the sugar juice from the beets, have been replaced by the diffusion batteries. A measure of uniformity has now been reached in the essential features of the processes and plant, though differences of detail are naturally found, for example, the

alternatives of the beet wheel or the mammoth pump for elevating the beets from the flumes to the washer.

In the older factories abroad, the gradual adoption of new methods involved replacement or adaption of the old machinery. The industry in this country, coming late into the field, profited by the experience of other countries and was able to start with a lay-out on the most modern lines, with a view to economy of labour and fuel for heat, light and power.

The manufacture of beet sugar from the roots in their fresh state is the system almost universally practised, although for many years, the method of drying and storing the sliced beets for subsequent manufacture with a view to spreading the work more evenly over the year has been experimented with this in this country and abroad and is, in fact, employed in two factories in Italy.

Many beet sugar factories on the Continent sell their raw sugar to central sugar refineries. In Germany, for instance, half the raw sugar is so treated, the remainder being made into white sugar by the beet sugar factories themselves. Beet sugar manufacture in this country, as in the United States, has been carried on from the outset by the "continuous process" system, – i.e., the complete production of white sugar from the beets in one factory, –and all the British factories except one built under the auspices of British refiners were constructed with this aim in view. It is, however, possible for all the factories in this country to stop at the raw sugar stage and send their product to the refineries for finishing. Some of the "continuous process" factories have done so in recent years.

In Continental countries, the question whether white sugar is made by the beet factories or whether the raw sugar is sent to the refineries depends for an answer upon financial conditions and local environment rather than upon the intrinsic economic merits of the two systems. Most of the sugar factories were built before the "continuous process" was developed, and the existing organisation of factories and refineries has therefore grown up on a basis of raw-sugar production by the beet factories.

The continuous process beet sugar factories turn out their white sugar in the loose, granulated form. The following description, the stages of which may be followed in the "flow sheet" is that of a continuous process factory, producing white beet sugar from fresh beets.

Fluming, Washing, Weighing and Slicing. – The beets on delivery to the factory by rail, road or water are unloaded into the factory flumes or silos. These are wedge-shaped troughs, at the foot of which are channels, protected by movable gratings of wood or sheet iron, along which flows a stream of water. Each grating is removed in turn, permitting the beets in the silo to fall or to be impelled by hand or water gun into the channels, along which they are transported into the factory by the stream of water, which at the same time partially washes them.

At the entrance to the factory the beets are elevated by means of a large wheel fitted with scoops, or by compressed air, into a beet washer. This consists of a horizontal trough, half-filled with water, and fitted with an agitator which churns up the contents and cleans the roots of adhering earth and stones. The agitator, a series of revolving arms, has a spiral action and thus impels the beets to the end of the trough, whence they are passed over a picking table where stones, pieces of wood and other foreign matter are removed. They are then carried by a screw conveyor and elevator to an automatic weighing machine which, on registering a given weight, discharges its contents into a trough, from which they are delivered into the cutting mills or slicing machines directly below. The cutting mills consist of rotating drums containing

horizontal serrated knives, which cut the beets into long wedge-shaped pieces, usually called "cossettes."

Extraction of Beet Juice, -- From the cutting mills, the cossettes are mechanically conveyed to the diffusion battery, where the juice is extracted. The process employed in the extraction of the juice is that of dialysis or osmosis. When two liquids of different densities are separated by a membranous partition, not sufficiently porous to enable liquid to pass through it by the force of gravity, a process of diffusion takes place, the denser passing into the lighter and the lighter into the denser liquid. If the denser liquid contains in solution a mixture of crystallizable and uncrystallisable substances, the former will diffuse freely, the latter hardly at all. Sugar beet juice fulfils these conditions, containing in solution not only crystallizable sugar, but also many gummy and gelatinous substances, which must be separated before pure sugar can be obtained. The cell walls of the beet roots, like those of plants generally, form a diffusing medium, and it is possible by diffusion to extract the sugar solution from the beets, leaving behind in the plant cells a large proportion of the impurities. This is, broadly, the process which takes place in the diffusion battery.

The diffusion battery usually consists of a group of large cylindrical vessels or cells, with conical ends, called diffusers. The number of vessels in the battery varies but is usually 14. The cells are charged with cossettes from the top. Water is introduced into the first cell; the temperature is raised by means of calandria heaters or direct injection of steam and dialysis or osmosis of the sugar solution in the cossettes takes place. The sugar juice thus obtained is passed slowly into the next diffuser by bringing in more fresh water under pressure. From the second diffuser, the juice passes to the next, and so on, the sugar juice circulating and becoming more concentrated until equilibrium of sugar concentration in the water and in the plant cell is almost reached, when dialysis ceases. As pure water has a very strong affinity for sugar, it is usual, as far as practicable, to bring fresh water into contact with nearly exhausted cossettes, and conversely, to bring the freshest cossettes into contact with the richest juice. The raw juice, which becomes almost black on exposure to the atmosphere, is then drawn off for further treatment. As the cossettes become exhausted of sugar, they are discharged from the bottom of the cell and conveyed to presses which remove a proportion of the residual water, leaving what is called "wet pulp."

Several of the factories in this country employ a modification of the diffusion battery called a "continuous diffuser". This consists of a long cylinder some nine and a half feet in diameter and eighty-two feet in length, inclined at an angle of 4 degrees to the horizontal. This is partitioned into 22 chambers, in each of which a paddle is fitted. The paddles lift the cossettes by stages from the lower to the higher end of the diffuser. At the same time, a stream of water introduced into the higher chamber flows in the opposite direction, raw beet juice being obtained by dialysis as in the diffusion battery. The water from the pulp presses is returned to the diffuser, and the sugar which it contains is thus retained.

Clarification, --The raw juice contains certain impurities which must be removed before the juice is evaporated and crystallised. The juice is, therefore, pumped through heaters, which raise the temperature from 80°C to 90°C., and passed to the lime mixers or defecation tanks. Here it is treated with lime from limestone burnt in kilns at the factory. The lime is fed into the lime mixers, either in the dry state or mixed with water to a creamy consistency known as milk of lime. About two percent by weight is added to the juice, the amount varying according to the quantity and nature of the impurities present.

The limed juice flows to the carbonation tanks, where carbon-dioxide gas from the lime kilns is pumped through it. The tanks are only about one-third filled in order to allow ample space for the frothing which occurs. The net effect of liming and carbonation is to precipitate the non-sugars together with lime, in a solid form, thus making it possible to remove them by filtration.

The gassing is continued until the juice contains about one-thousandth part of free lime. The juice is now pumped through heaters and then through filter presses, generally of the plate and frame type, the frames being covered with canvas filter-cloths which retain the precipitated non-sugars and calcium carbonate as "lime-cake" or "lime sludge," allowing the juice to emerge as a clear, straw-coloured fluid.

The filtered juice is then pumped through heaters to the second carbonation tanks, where carbon dioxide gas is again pumped through it until almost all trace of lime is precipitated. The reason for carrying out carbonation in two stages is, that if, in the first instance, alkalinity was reduced by gassing beyond a certain point many of the precipitated impurities would be redissolved. It is, therefore, necessary to remove such substances by filtration before completing the process.

After the second carbonation, the juice is again pass through filter presses, heated and again filtered. The filtered juice contains a small trace of ammonium, sodium and potassium carbonates.

As these products would become very viscid on boiling, a stream of sulphur dioxide is passed through the juice to convert these carbonates into sulphites, which boil much more freely, and further to clarify the juice. The juice is then filtered through fine cotton-bag filters to ensure that before evaporation the last trace of sediment is removed.

The lime-cake or sludge from the filters is flaked off the filter frames into a well, from which it is transported, either by mixing with water and pumping, or in the dry state by trolleys, to the lime pits. At some factories the lime is dried in a mechanical drier.

Evaporation, --The thin juice, now clarified, is concentrated in evaporators, consisting generally of 3, 4 or five vessels, each fitted near the bottom with a calandria or steam coil. The juice in the first vessel is boiled by allowing exhaust or live steam to enter the calandria; the hot vapours from the juice then enter the calandria of the second vessel, and the juice boils in this vessel, its vapours entering the third calandria, and so on to the last vessel.

The vapours of the last vessel are drawn into a barometric condenser, where they are condensed. Boiling takes place in the vessels either under pressure or under vacuum, which diminishes in intensity from the last backwards; in the first vessel, the juice is usually boiled under slight pressure.

The juice flows from one vessel to another in the evaporator, its concentration increasing until the water content has been reduced by about 75 percent, when it is pumped in the form of a syrup through filters to the vacuum pans.

Sugar Boiling and Crystallization, --In the vacuum pans, which are heated by steam supplied to calandrias in the bottom of the pans, the syrup is boiled under vacuum. This enables boiling to take place at a low temperature and thus prevents "caramelization", i.e., oxidation of sugar.

The syrup is concentrated to super-saturation point, or “graining point”, when crystallization commences. Graining point is indicated when, on extracting a sample of the syrup through a tap and allowing it to flow over a glass plate, a thin layer of crystallising sugar is formed. At intervals, further quantities of the syrup are passed into the pans and concentrated until the vessels are full of liquor containing crystallized sugar, or “massecuite”, as it is then called. The massecuite is then discharged into crystallisers, –horizontal cylindrical tanks fitted internally with stirrers, which slowly rotate and gradually cool the massecuite. The effect of gradually cooling such a highly concentrated syrup is to bring about a retarded crystallization.

At the correct stage, the massecuite is passed into centrifugal machines for the purpose of separating the crystals from the mother liquor. The centrifugal's are large, but comparatively shallow cylindrical vessels fitted internally with baskets of finely woven brass screen attached to a vertical spindle, and are rotated at from 900 to 1000 revolutions per minute.

The massecuite is flung by centrifugal force against the walls of the baskets, the mother liquor being forced through and the sugar retained on the screen. The mother liquor is drawn off and the hot, moist, white sugar is discharged to a conveyor below, which carries it to a granulator, where it is cooled, dried and screened. It is then bagged and stored ready for delivery from the factory.

The mother liquor from the centrifugal's is pumped into separate vacuum pans, re-boiled, crystallised and again passed through the centrifugal's. This is usually re-melted, –mixed with water or thin juice at a temperature of 80 degrees centigrade, so as to make a 50 percent to 60 percent sugar solution, –mixed with the syrup from the evaporator's and re-crystallized.

This process is repeated until as much sugar as possible has been extracted from the mother liquor as white sugar, (polarising ex 99°).

The final residue after the second or third “running” is called molasses, and is pumped into the molasses tanks. It still contains about 50 percent of sweetening matter, the greater proportion of which, though crystallizable, can only be separated from the other sugars and impurities remaining by very intricate processes.

The Raw Sugar Factory, --The factory, which makes only raw sugar for refining does not carry its first running's to the point of white sugar in the centrifugal's. It may or may not remelt its second running's and third running's, (if any).

It is in the interest of a raw sugar factory in this country, under the present Excise and Subsidy scales, to remelt running's which do not exceed polarising ex 98°. Raw sugar contains a certain amount of the mother liquor and, in consequence, a raw sugar factory makes less molasses than a white sugar factory.

The function of the refinery is to extract the molasses from the raw sugar by remelting and finishing processes.

In recent years there has been an increasing tendency for beet sugar factories in this country, partly on account of the fiscal advantages thereby obtained, to stop short at the raw sugar stage and to send the resulting product to the refineries.

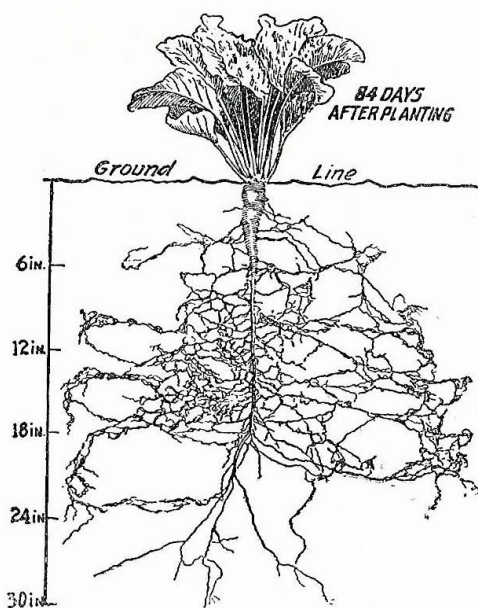


FIG. 4.—The Sugar Beet's Action on the Soil during growth.

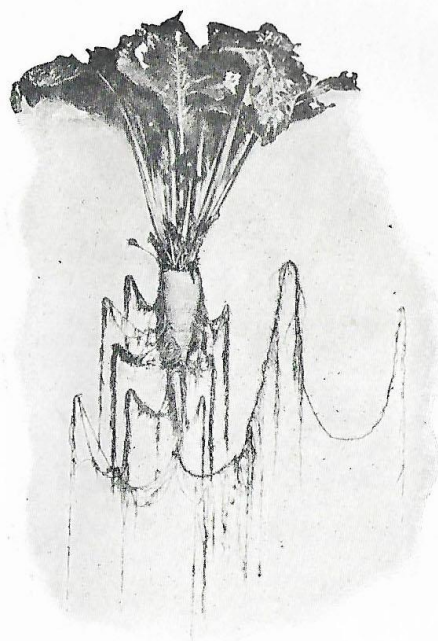


FIG. 5.—Root Formation of the Sugar Beet.



FIG. 16.—Hoeing.



FIG. 15.— Singling.

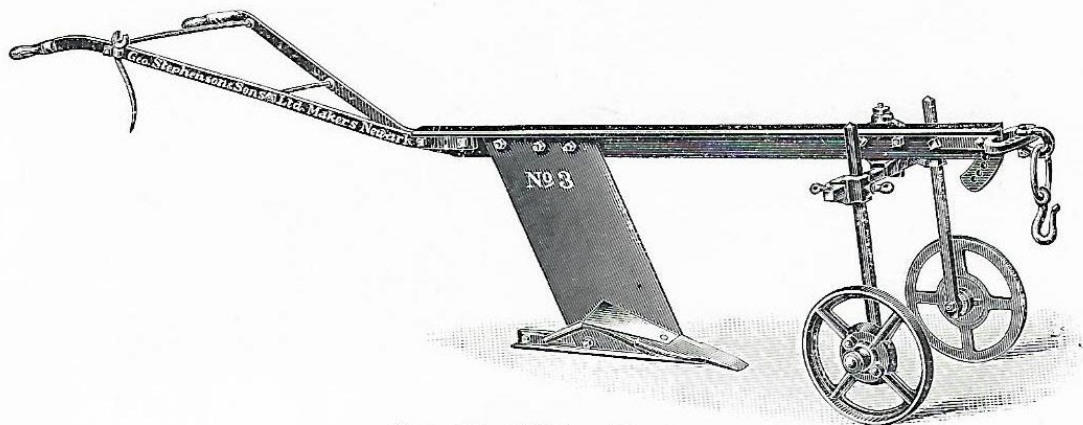


FIG. 17.—Lifting Plough.

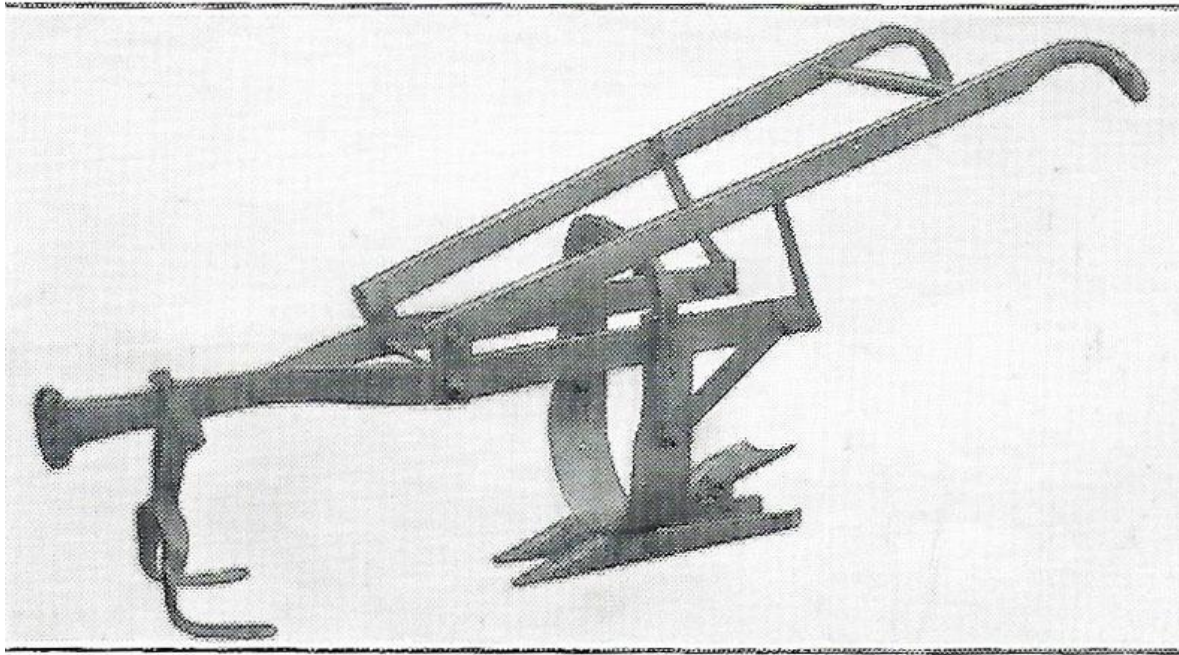


FIG. 18.—Lifter.



FIG. 27.—Loading Sugar Beet to Farm Wagon.



FIG. 30.—Unloading Sugar Beet from Road Transport.



FIG. 31.—Water Transport of Sugar Beet.



FIG. 32.—Unloading Sugar Beet by “Grab.”

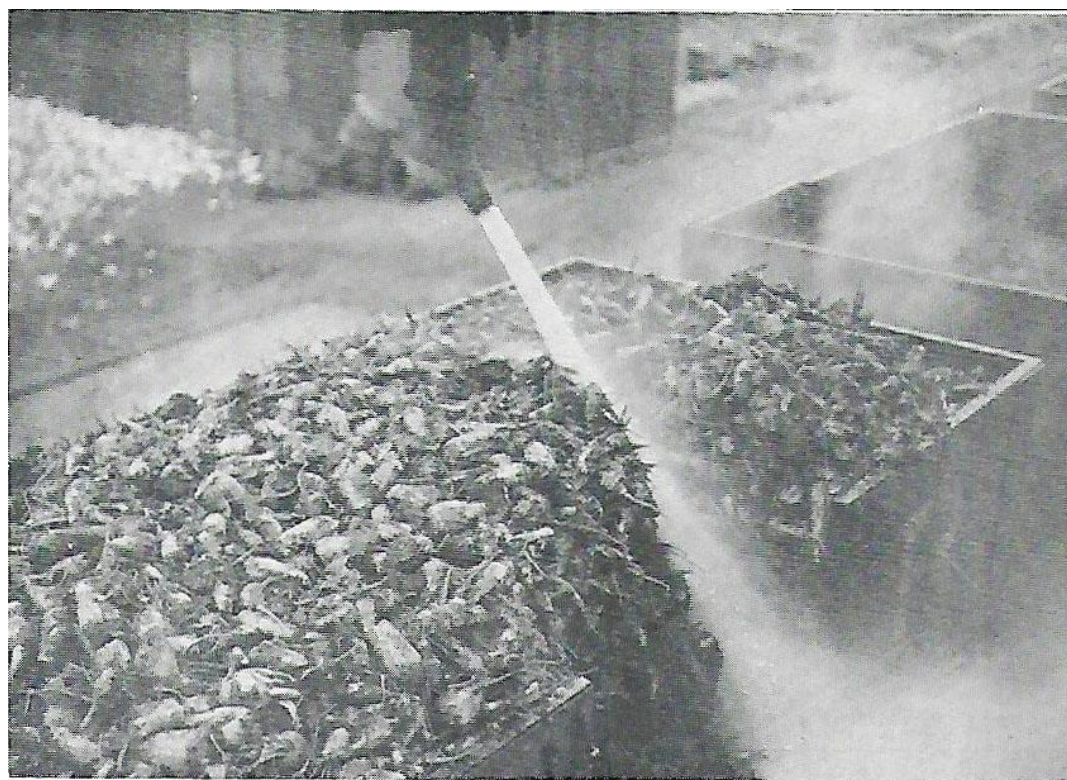


FIG. 34.—Unloading Sugar Beet by “Elfa,” or Water Gun.

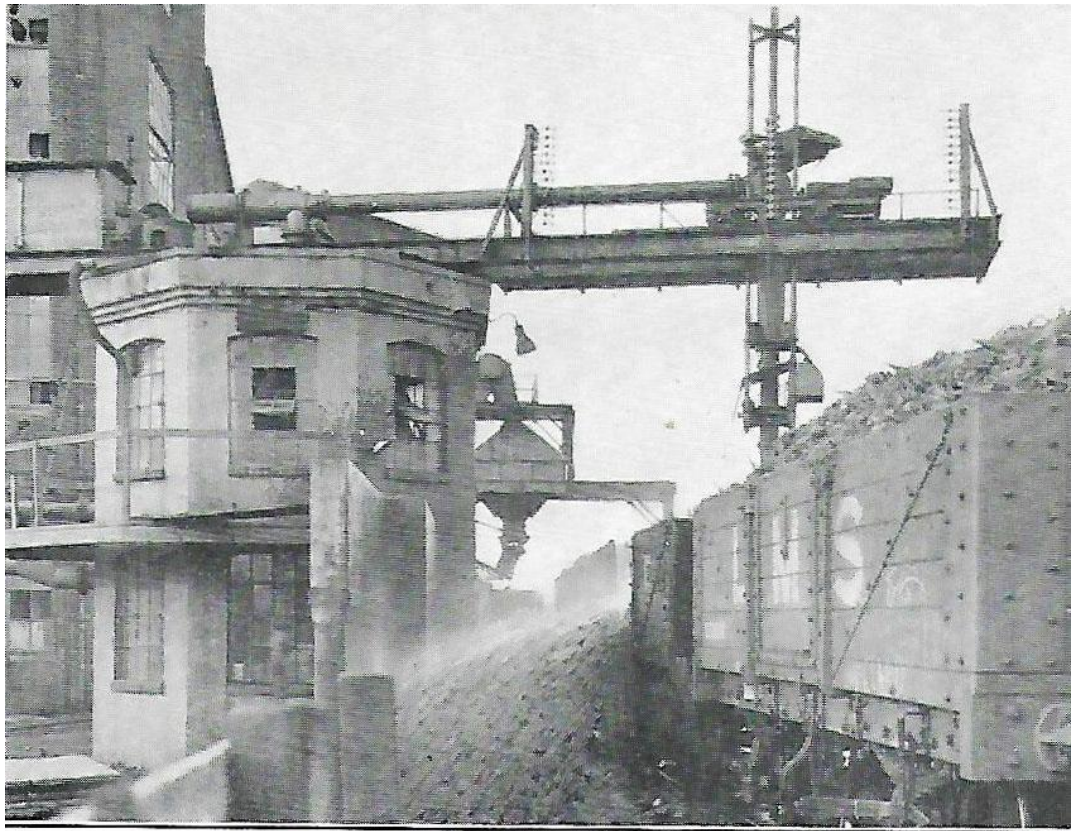


FIG. 35.—The “ Elfa ” Tower.

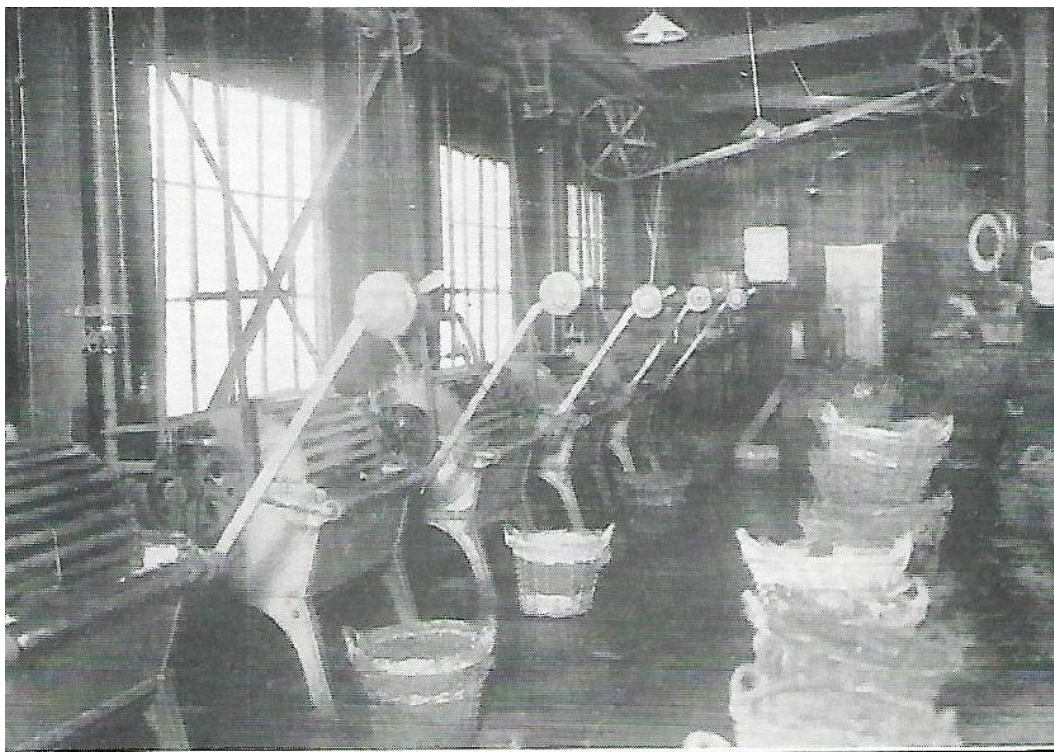


FIG. 36.—Tare House.

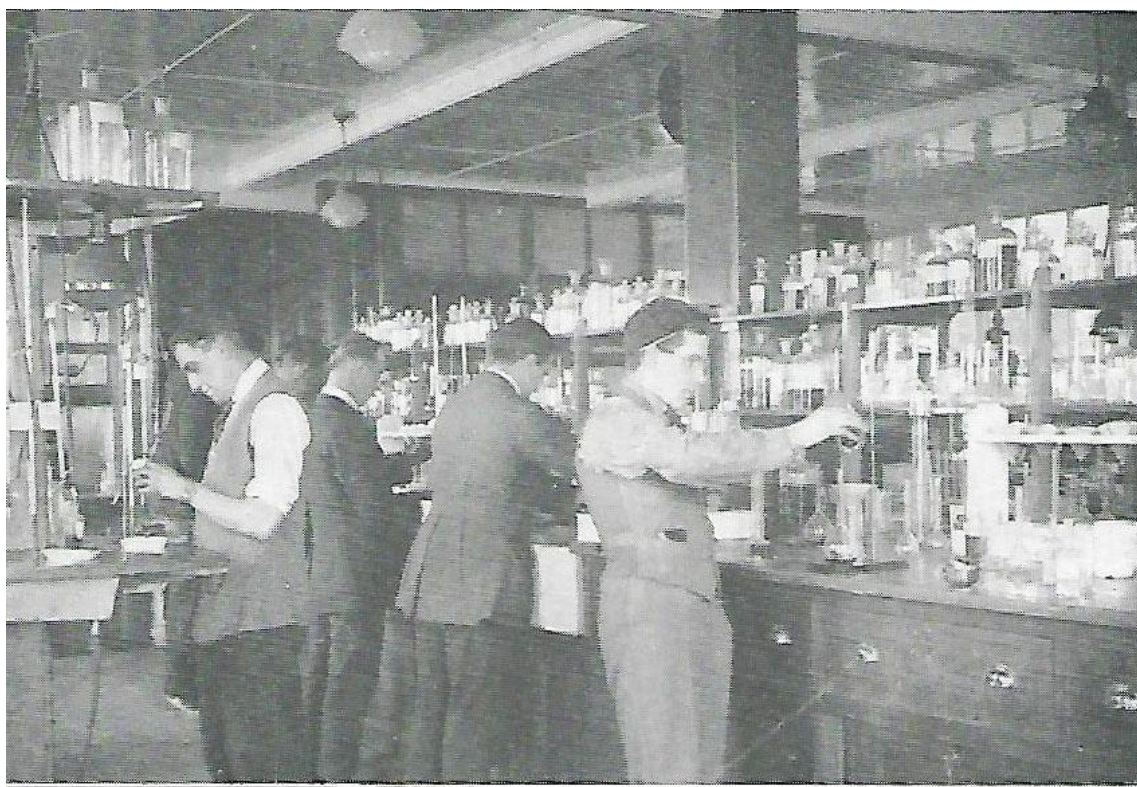


FIG. 37.—Laboratory.

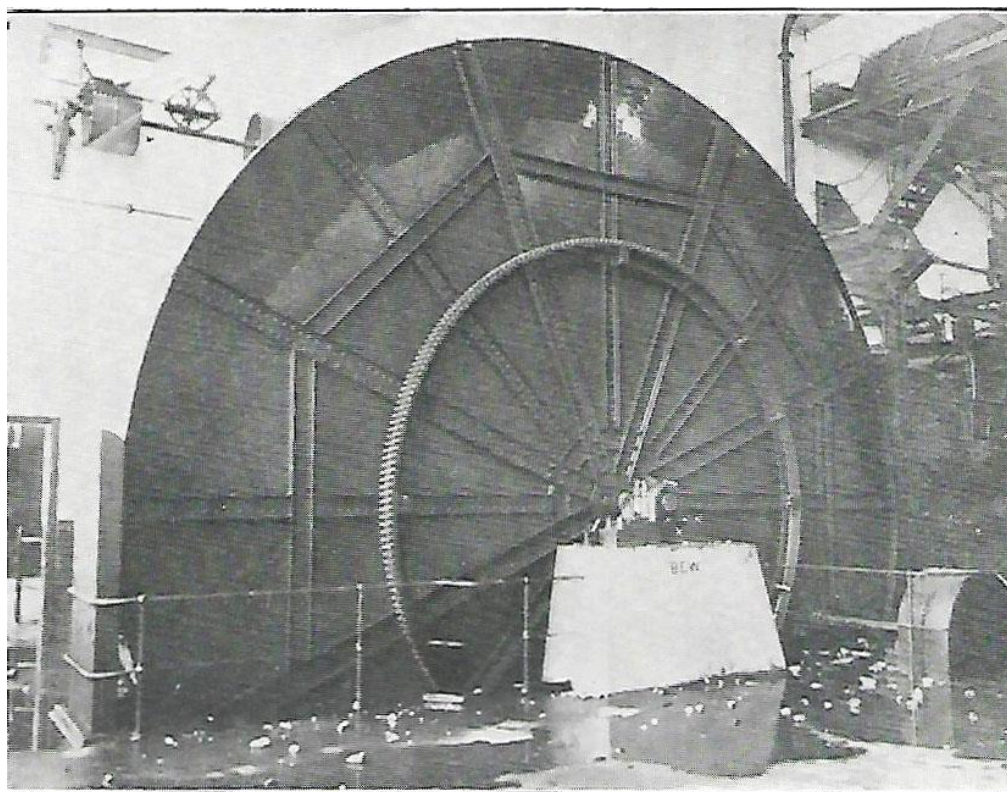


FIG. 43.—Beet Wheel for Elevating and Washing.

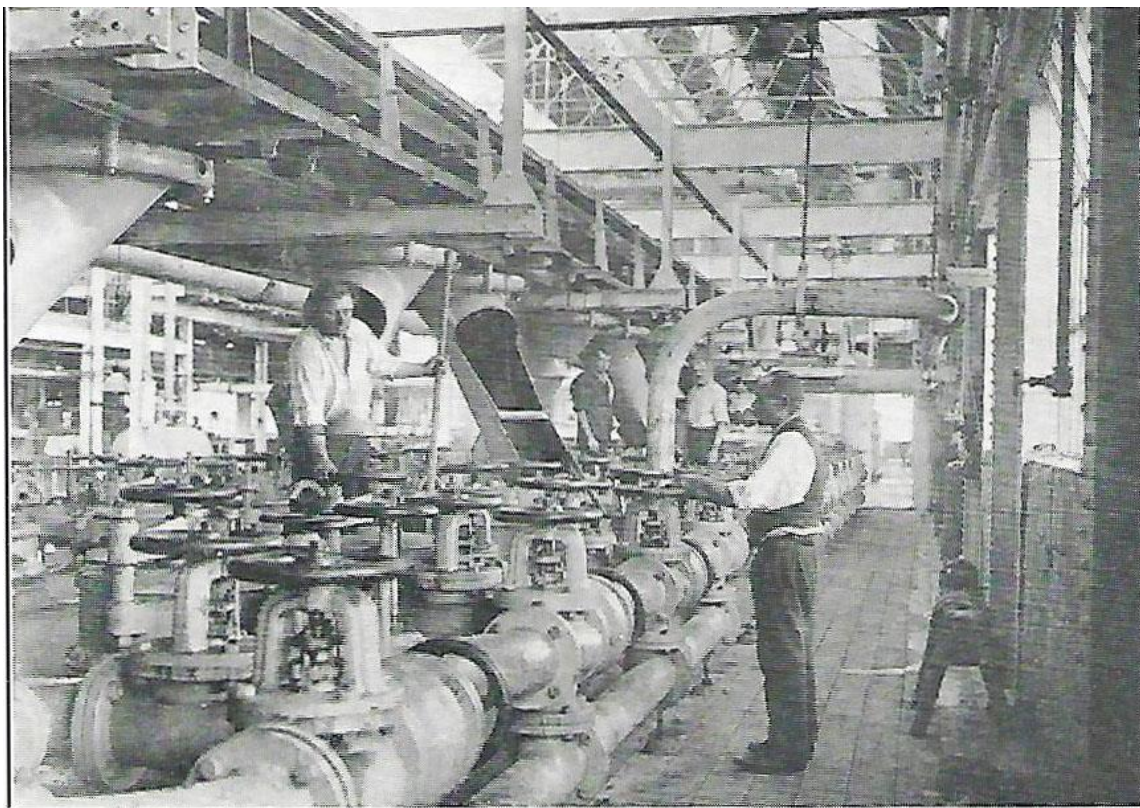


FIG. 44.—Diffusion Battery.

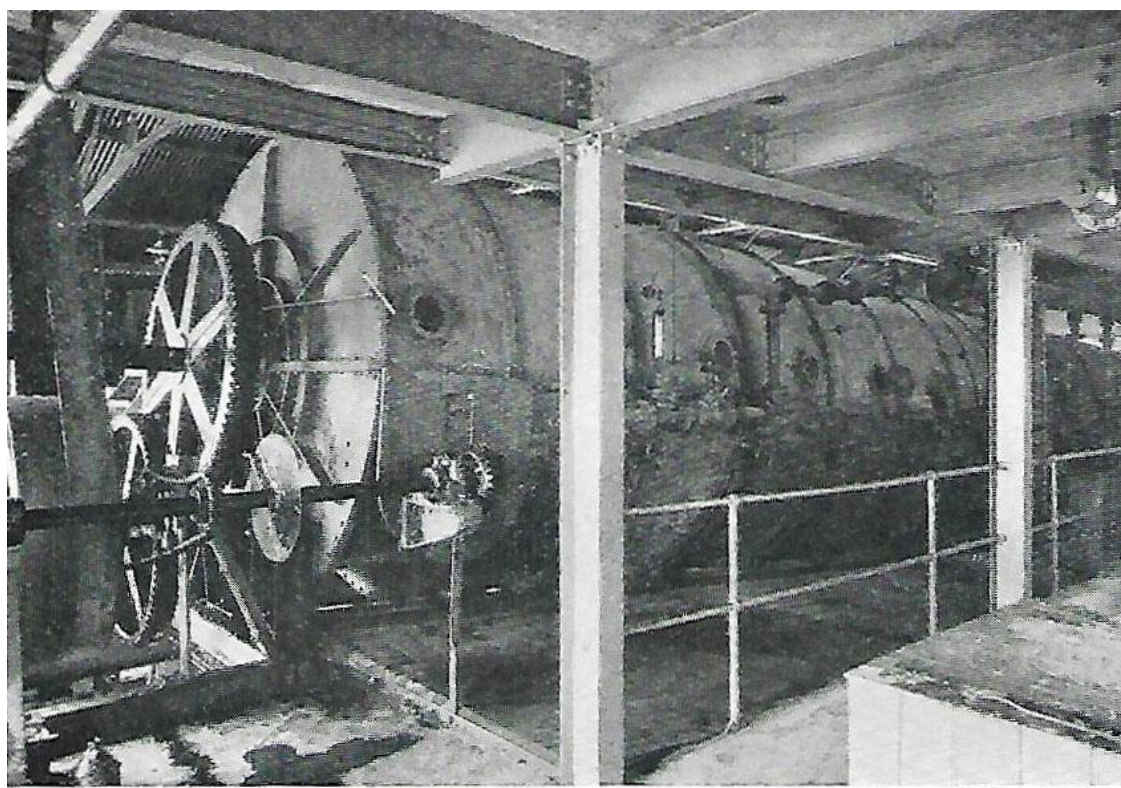


FIG. 45.—Diffusion Battery (Raabe Process).



FIG. 46.—Lime Mixers.

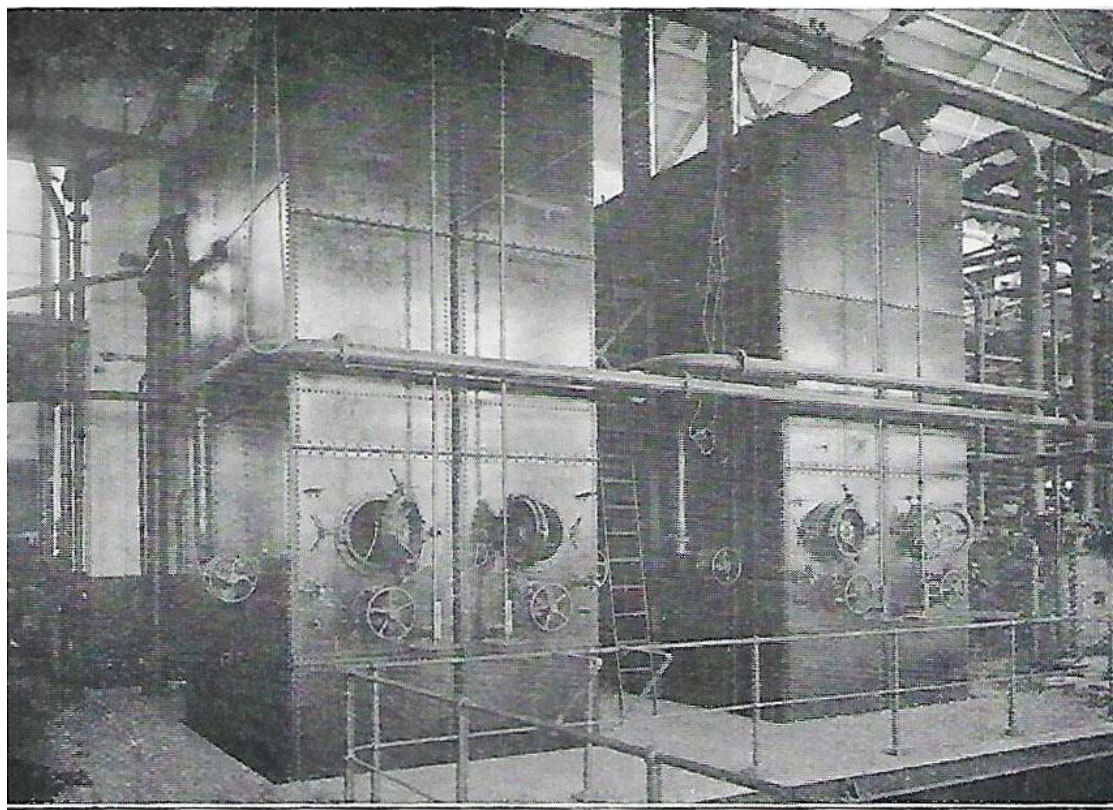


FIG. 47.—Carbonatation Tanks.

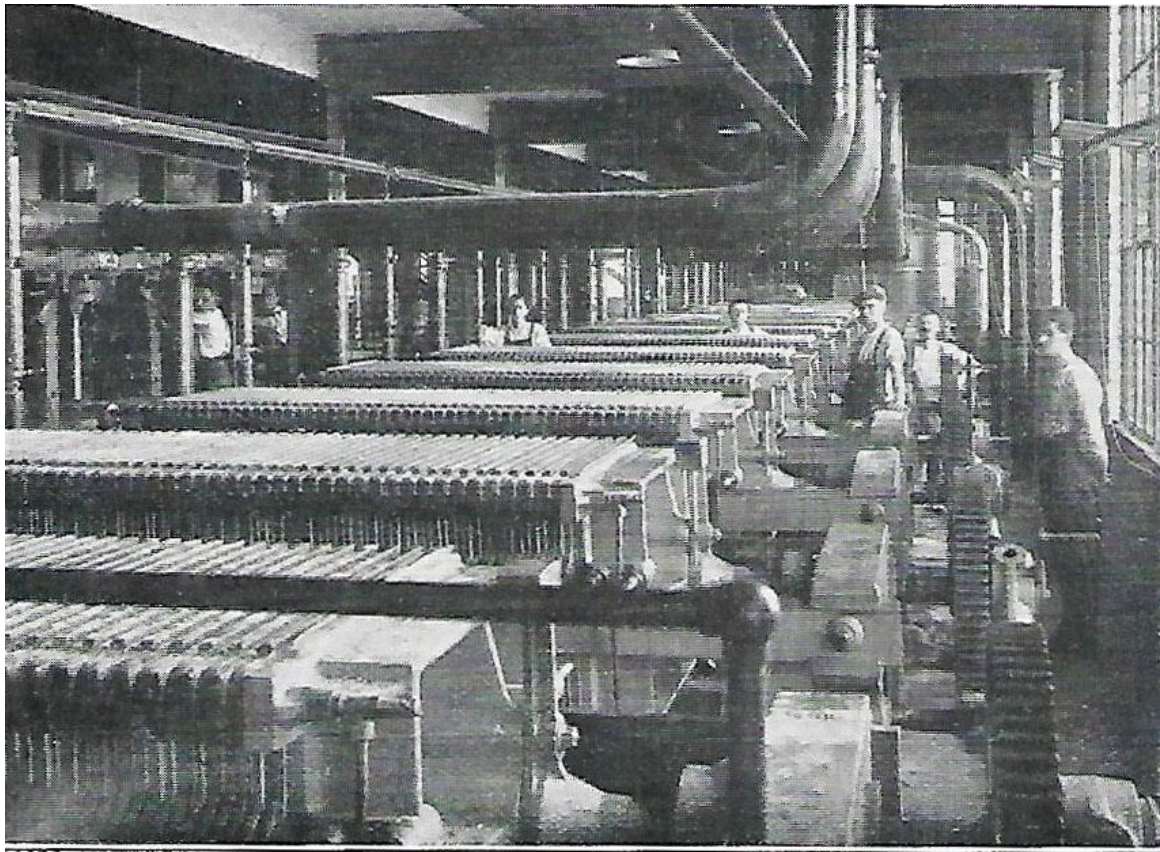


FIG. 48.—Filter Presses.

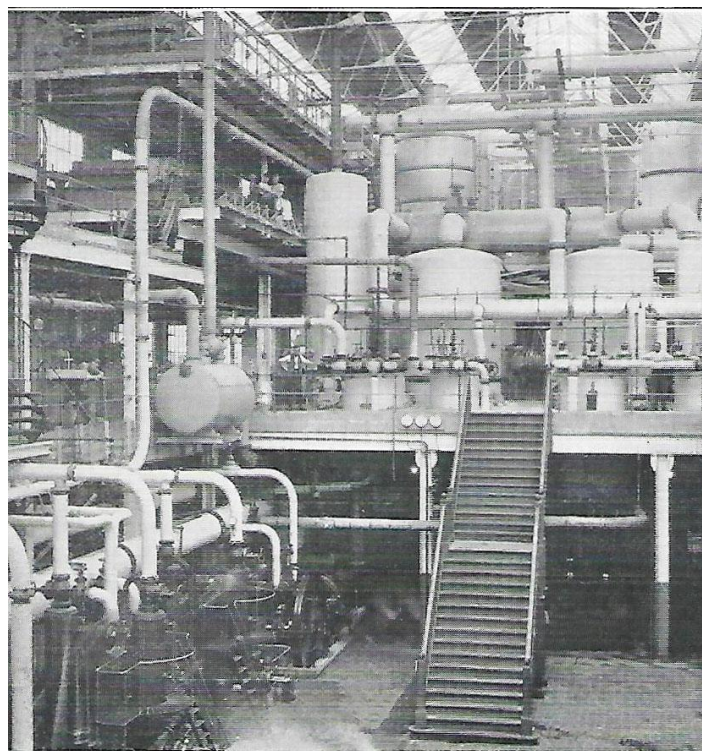


FIG. 49.—Evaporators.

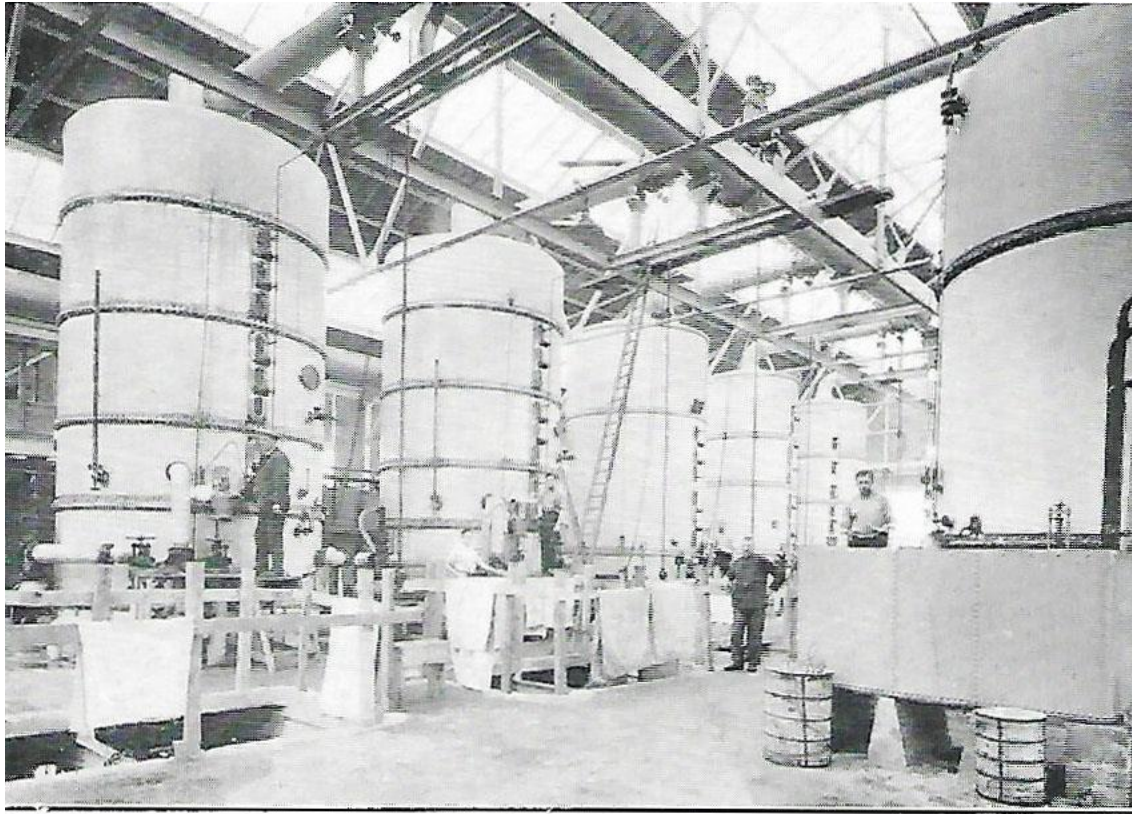


FIG. 50.—Vacuum Pans.

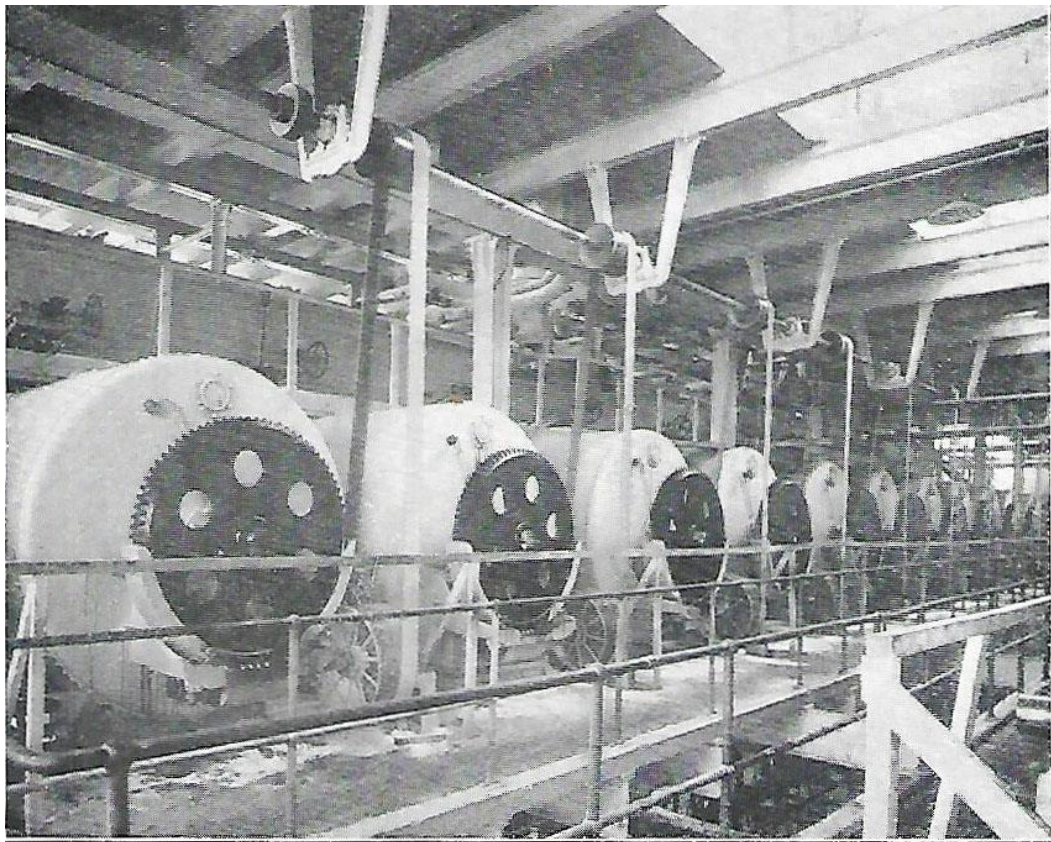


FIG. 51.—Crystallizers.

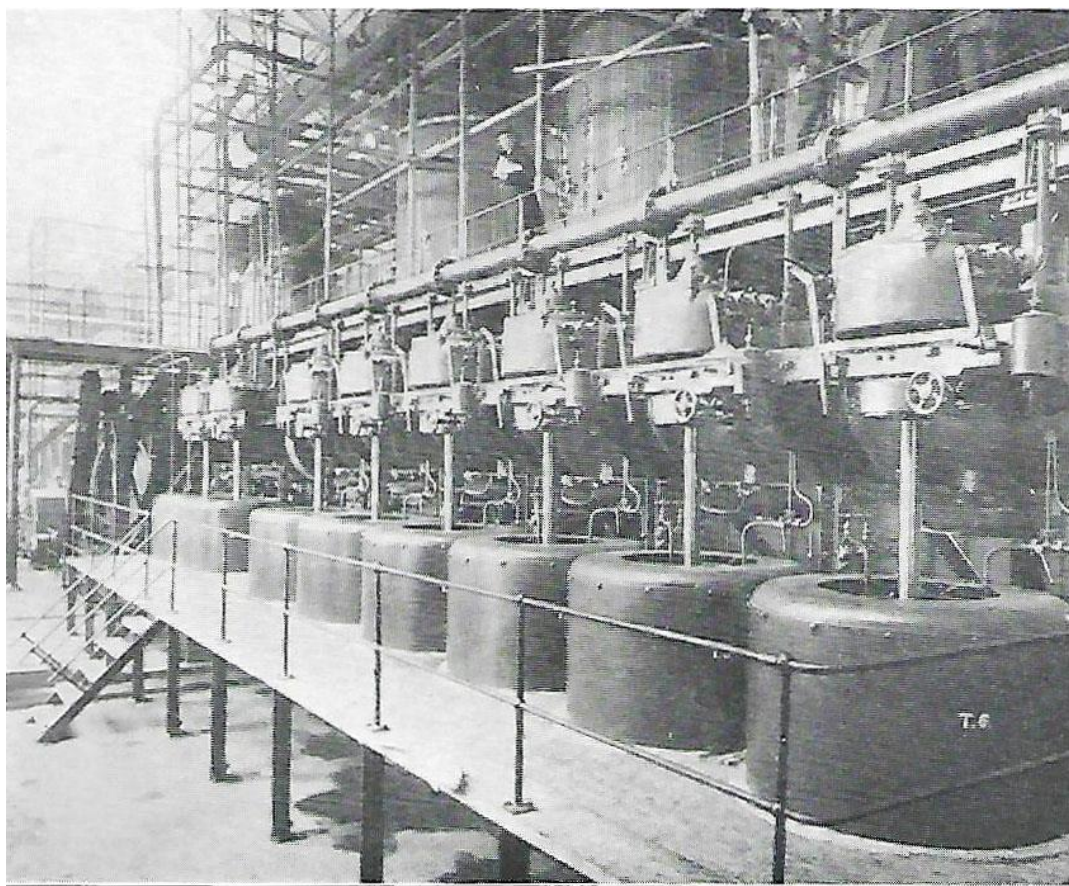


FIG. 52.—Centrifugals.

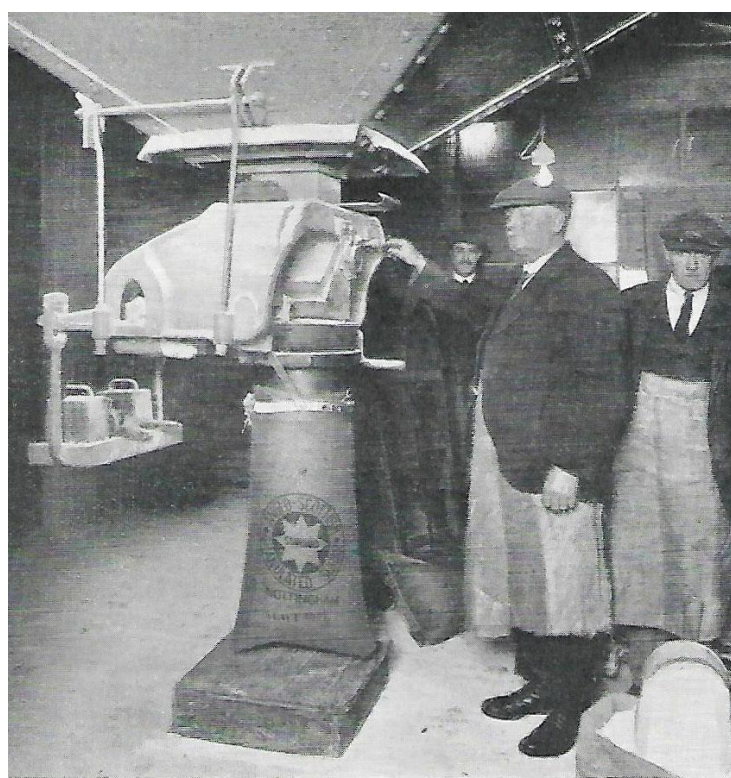


FIG. 53.—Weighing and Bagging Sugar.



FIG. 54.—Warehousing Sugar.

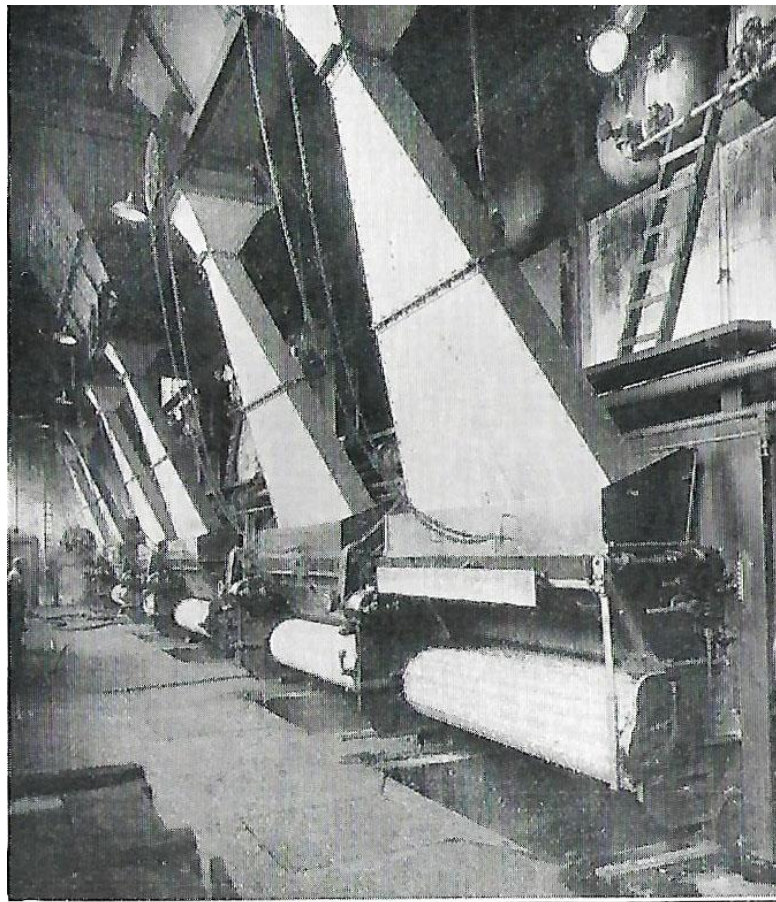


FIG. 55.—Boiler House.

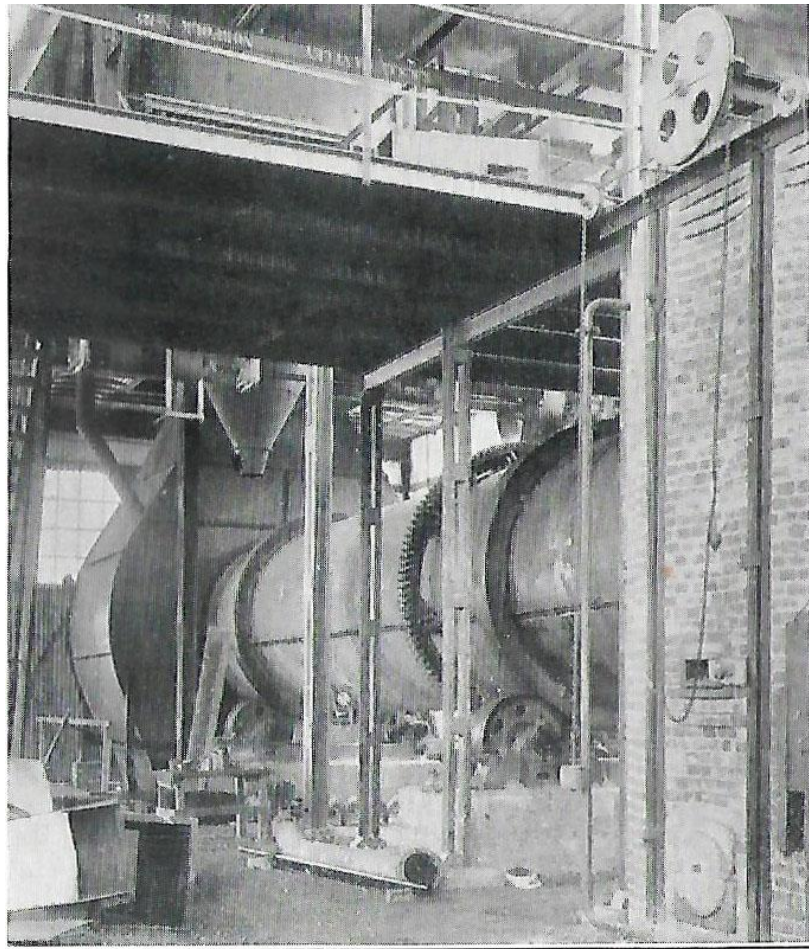


FIG. 56.—Pulp Driers.



FIG. 60.—“Detritus” or Sedimentation Ponds.



FIG. 61.—Effluent Filters.

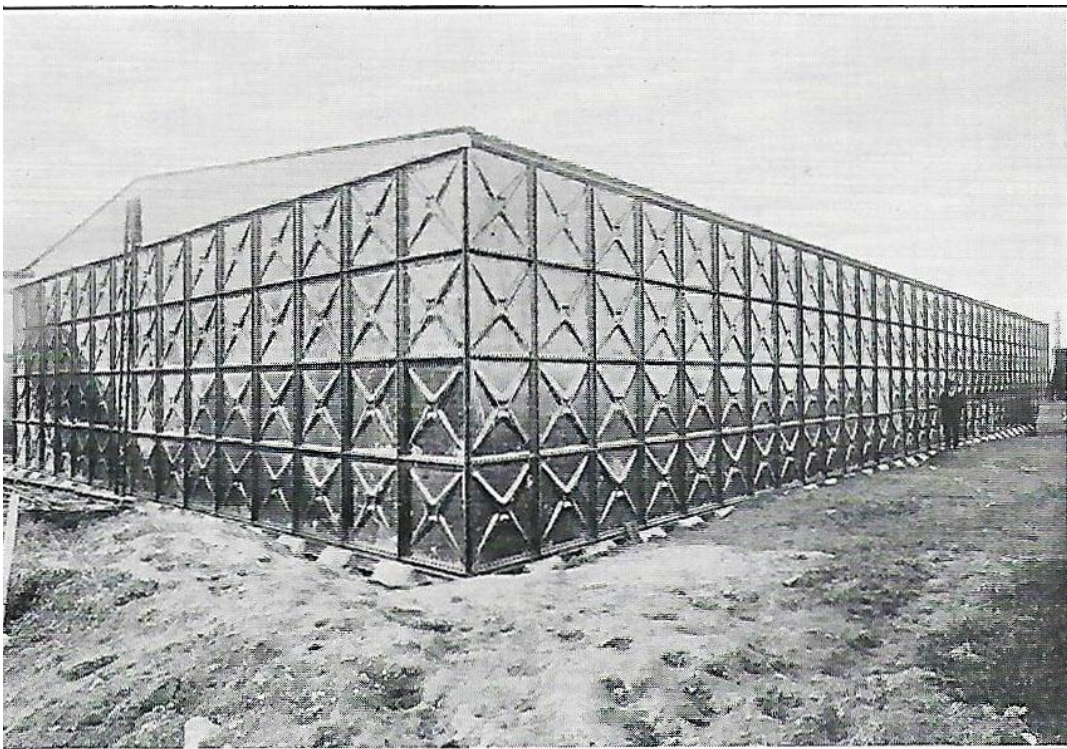


FIG. 63.—Molasses Storage Tank.

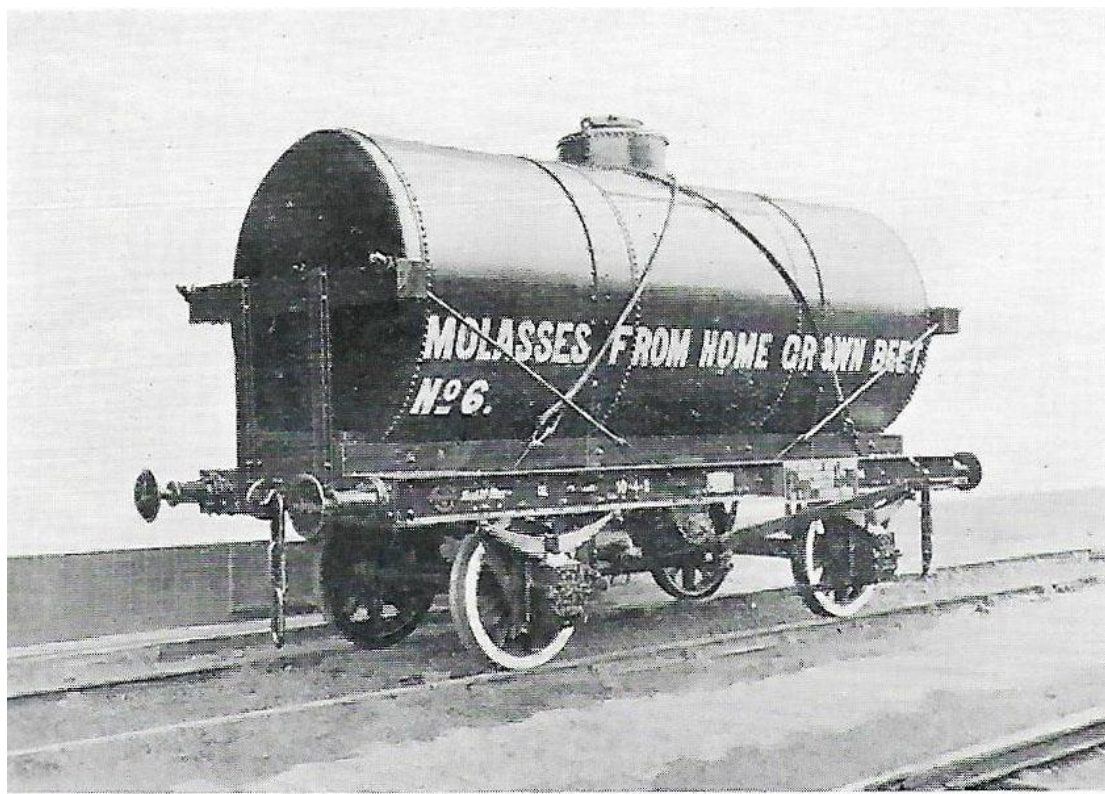


FIG. 64.—Rail Transport of Molasses.

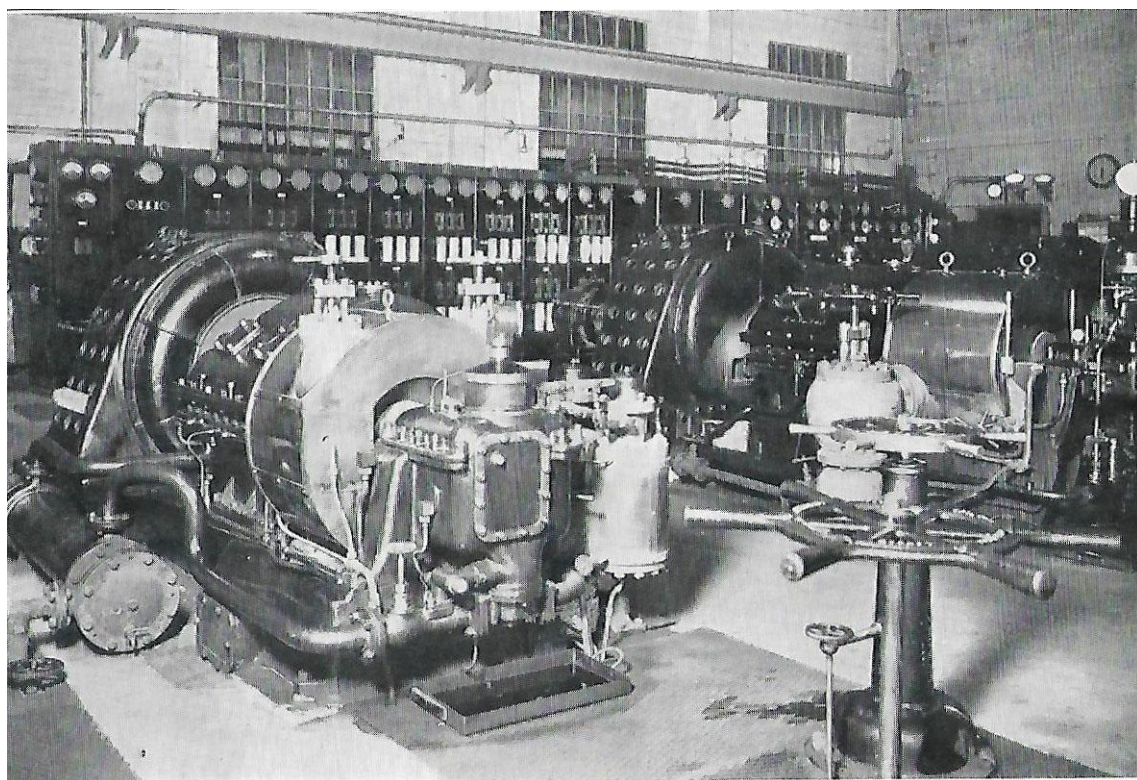


FIG. 65.—Power House.

Factory By-products: Molasses, Pulp, etc. Molasses. Molasses is the by-product remaining after the recovery of sugar from the massecuite in the centrifugal's. It is a thick, dark substance, of which the chief constituent is sucrose, which forms about 60 percent of the dry matter, or from 50.5 percent to 51 percent of the total weight. Molasses contains also about 10 percent of albuminoid material, 7 percent to 10 percent of ash, –rich in potash, – and from 15 percent to 30 percent of water. The percentage of water in the molasses largely determines its keeping properties; diluted molasses rapidly becomes sour. The output of molasses in a diffusion-process factory is equal to from 25 percent to 35 percent of the output of white sugar.

Uses of Molasses. Beet molasses is largely used both in this country and abroad as food for stock, for which purpose it is either mixed with pulp by the factory or sold in drums to farmers for mixing with coarse fodders, such as chaff, or with such feeding-stuffs as palm-kernel cake. One of the principal uses of molasses both in this country and abroad, is in the manufacture of alcohol. Suggestions have been made that the British beet sugar factories should themselves manufacture alcohol from molasses. This proposal has been examined by the factories, but it is considered more economical to sell to the distilleries all molasses not used in the manufacture of food for stock. The cost of a distillation plant to work 80 tons of molasses daily is about £20,000, apart from the cost of storage of molasses at the beet factory. In 1927, the Government appointed a small expert Committee to consider the possibilities of the manufacture of alcohol for power purposes from the sugar beet itself. The report of the Committee lent no support to the belief that the production of power alcohol from sugar beet would be profitable, even with the assistance of a subsidy at the rates then ruling for sugar.

A small proportion of the molasses produced is used in the production of yeast and polishes. A large proportion of home-produced molasses not used as food for stock is exported to the Continent.

The average price received by the factories for molasses has varied substantially during the subsidy years. In 1924, it was 5 shillings and four pence per hundredweight, in 1925, two shillings and 6 pence., in 1926, 1 shilling and seven pence., in 1927, one shilling and 6 pence., in 1928, two shillings and five pence., and in 1929, two shillings per hundredweight, in bond, ex-factory.

The present Excise duties on molasses in this country are two shillings and 8 pence per hundredweight for molasses containing 50 percent to 70 percent sweetening matter, and one shilling and 3-and-a-half pence for molasses of less than 50 percent sweetening matter, but as molasses exported or used for distilling, for yeast-making or food for stock is duty- free, the beet sugar factories pay no Excise duty on this product.

Wet Pulp. The sliced beets, or cossettes, after diffusion, are known as beet pulp. This is a valuable food for stock, for which purpose they may be disposed of either wet, dried or mixed with molasses. 100 tons of beet yield from 40 to 50 tons of wet pulp. Wet pulp after pressing contains from 8 percent to 15 percent of dry matter, practically all digestible, and as a stock-food is interchangeable with turnips and mangolds.

The standard form of contract between factories and growers in this country, in fact, makes no reference to deliveries of wet pulp. The difference between the practice in this respect in Great Britain and abroad, is partly due to the fact that abroad a large proportion of the beet-growing farms are within carting distance of the factory, and the carts which deliver beets to the factory

take back wet pulp to the farms. In this country difficulty has been found in inducing growers, even within a short radius of the factory, to take any considerable quantities of wet pulp.

Wet pulp quickly deteriorates. In the early years of the industry in this country, large quantities were wasted by one or two factories which had either inadequate drying plants or none at all. At one British factory, where wet pulp is sold to neighbouring farmers, the price charged is 4 shillings per ton ex-factory to growers and five shillings to non-growers.

Dried Pulp. In Great Britain, pulp driers are now installed in all the beet sugar factories. The pulp is dried either by the Buttner or by the Imperial process. In the Buttner process, the drying takes place in a cylindrical drum revolving about 2 1/2 times per minute, and thus keeping the pulp in continuous movement. The wet pulp enters from above and is passed along the drum by worm action. The pulp, as it enters the drier, is exposed to the full heat of the gases from a brick furnace, but the temperature of the moist pulp does not exceed 100°C, and it therefore does not char. In the Imperial process, the furnace gases from the main factory boiler-house are used. The drying apparatus consists of a revolving drum contained in an outer fixed drum. The wet pulp is fed into the space between the two drums and is kept in motion by palettes attached to the revolving drum.

Dried pulp is of a light grey or dark brown colour, according to the process used. 100 tons of beet yield, on the average, from 5 to 6 tons of dried pulp. The dried pulp is delivered from the factories, usually in one hundredweight bags. The cost of drying is estimated at from 13 shillings to 14 shillings per ton of dried pulp, excluding the cost of bags and any allowance for depreciation of plant and interest on capital.

Industrial Labour. The Factory: A Source of Industrial Employment. In the erection of a beet sugar factory, considerable employment is provided, both in the engineering and building trades, as well as for general workers. Once erected, it provides employment for industrial workers in the reception and dispatch of raw materials, in the factory processes and in the handling of finished products.

Indirect Employment. Apart from the direct employment it provides, the sugar beet industry creates indirect employment in a number of other industries, –in the transport of fertilisers and seeds to the farmer and of the bulky sugar beet crop to the factory, in the supply and transport of the coal, coke, limestone, bags, etc., required by the factory, and in the distribution of the products, –sugar, molasses, pulp and lime waste. The additional employment so provided cannot be reliably estimated, but it is clearly substantial.

Labour in Factory Construction. A leading British firm of sugar machinery manufacturers, after an investigation involving an analysis of cost and labour sheets by all the contractors and sub-contractors concerned, has stated that the erection and equipment of a factory with a capacity of 1,200 tons of beet per day would provide employment to the extent of 393 man-years of skilled, and 446 man-years of unskilled, labour, assuming a normal working week.

The above figures include the employment provided in the manufacture of machinery and in the preparation of that part of the complete material which is forwarded in a finished or semi-finished state, as well as the labour involved in the erection of the factory., including the flumes, road approaches, private sidings and the houses of the principal officers. No allowance has been made, however, for the manufacture of steel plates, rails, bricks, cement, etc, treated as

raw materials. The figures include the making of iron castings but do not cover the manufacturer of the raw materials required, such as pig iron, coke, coal, etc.

General Staff. The general staff of a beet sugar factory in this country usually comprises: --

- (a) a factory manager.
- (b) a commercial manager who controls the commercial and accounting departments and also in some cases, the agricultural department.
- (c) an assistant or works manager.
- (d) two or three shift superintendents.
- (e) a chief engineer and an assistant engineer.
- (f) a chief chemist and 2 or 3 assistant chemists.
- (g) an accounting and other office staff, averaging 15 in permanent employment, supplemented by a further 7 for the campaign period.
- (h) a chief agriculturist where the work is not included in the duties of the commercial manager.
- (i) a number of fieldmen, averaging 8 per factory and resident in allotted sections of the growing areas., and,
- (j) a number of temporary beet contract agents, acting with the fieldman in obtaining beet contracts with growers.

The total number on the general staff of all the factories in 1929, excluding 51 alien assistants, was 783, of whom 645, or 36 per factory, were permanent officers, and 138, or 8 per factory, were employed for the period of the campaign only.

Seasonal Nature of Factory Operations. The operations of a beet sugar factory are necessarily seasonal. The factory can only work from the time the beets are ripe for harvesting and for so long as it is possible to store them without deterioration. In consequence, the factory is called upon to carry out, in the space of from three to four months, the whole of its manufacturing operations for a year. This necessitates working at high pressure, with as few interruptions or delays as possible, and without regard for Sundays and statutory holidays.

A factory aims at running its machinery without cessation throughout the "campaign" from the moment the machinery is started up until the last load of beets has been absorbed and the sugar, pulp molasses produced therefrom have been properly stored. During this period, therefore, labour must be continuously employed on the factory processes by means of relays or "shifts". The technical managers and foremen must also work on the "shift" system. Long periods of daily service are also required of the commercial and accounting staff and the transport and yard workers, though, in their case, the shift system is not essential.

Off-Season Operations. During the remaining eight or nine months of the year, –the "off season", –the factory is not idle. This intervening period is occupied in overhauling the whole of the plant and machinery, a reduced number of men being retained for the purpose. In the early years of the industry in Great Britain, this work of re-equipping and re-adjusting the plant occupied practically the whole of the off-season, but now, as a result of experience an organisation, some of the factories have been able to engage in subsidiary enterprises, such as the refining of imported raw sugar, the desugarization of molasses (in some seasons), the drying of lime waste and the manufacture of fertilisers.

Classification of Factory Labour. The labour employed in a factory is partly permanent and partly seasonal, the permanent labour being only a small proportion of the whole personnel. Both of these classes of labour may be subdivided into skilled and non-skilled, using the word

"skilled" to imply not only the "skilled trades" but also those general workers who have been appointed as "charge hands". The trades from which the skilled workers are drawn are principally fitters and welders, turners and blacksmiths, crane drivers, stokers and electricians, the terms and conditions of their employment being approved by their appropriate Trade Unions. The majority of the workers, however, are general labourers, whose terms and conditions of work are also arranged in accordance with Trade Union regulations, which are also applied to those general labourers who may not be members of Trade Unions.

The workers may again be divided into "inside" and "outside" workers. The "process" or "inside" workers are those occupied in the actual production of sugar; "outside" or "yard" workers are employed in the reception of the beets and the loading and dispatch of the factory products.

In a beet sugar factory, there are usually about 40 posts or stations, each requiring a "charge hand" with a number of assistants varying with the nature of the post. The work at most of these posts does not fall within the description of "skilled trades". Opportunity is therefore provided for the training of general or non-skilled workers to become "charge hands" when they're classed as skilled.

The classification of beet sugar factory labour in Great Britain during the campaign 1929 to 1930.

Main sugar house, Lime house, Boiler house, Pulp house, Factory, Laboratories, Workshops, Stores, Tare house and Beet Laboratory, Weighbridges and Yard.

Employment of Alien Labour. The employment of alien labour in the British factories was necessary in the early stages of the industry because the factory processes were unfamiliar, both to the British managerial staff and to the factory workers. There was, indeed, no prospect of success without the very best alien help. Permits to enable aliens to be admitted to this country for employment are issued by the Ministry of Labour under the powers vested in the Minister by Article 1 (3) (b) of the Aliens Order, 1920. The policy underlying the administration of this Order is such as to ensure that no alien is admitted for employment in any occupation for which suitable British labour is available. Applications for permits in respect of alien technicians, etc. for sugar factories have been considered by the Ministry of Labour in consultation with the Ministry of Agriculture and Fisheries.

The aliens employed fall under two general headings, –the managerial and supervising staff who are continuously employed, and the expert technical foremen or charge hands employed for the campaign only. The former have their passports endorsed, usually for 6 or 12 months at a time, so that the position is reviewed at least annually. The latter are admitted in October on a 4-months permit estimated to cover the duration of the campaign. In both cases, a guarantee has to be given that (a) no British labour is displaced, and (b), the alien is charged with the duty of training British staff. It has been appreciated in considering applications, that the larger the factory, the greater number of aliens required, and that more generous treatment should be accorded to a factory in its earlier campaigns than in later years, when it might reasonably be presumed that British workers, then semi-trained could to some extent replace the alien assistants.

The Shift System. The necessity for the shift system of labour organisation in a beet sugar factory, both on account of the continuous nature of the processes and the pressure of work

during the campaign, has been emphasised. At present, in the principal beet-growing countries of Europe, three shifts of eight hours each are worked per day; if the factory is unfavourably situated for obtaining labour, twelve-hour shifts are resorted to for at least the more important posts. In the United States, the twelve-hour shift is the rule, although the eight-hour shift is applied in some of the more successful concerns.

In the British factories, the eight-hour shift has been the standard aimed at from the beginning of the industry, except for the alien technical assistants who work twelve-hours at a time. As the number of factories increased, however, the twelve-hour shift was resorted to for the majority of the posts, particularly in the newer factories where satisfactory labour was difficult to obtain. In later years, these factories have made increased efforts to avoid the twelve-hour shift.

The twelve-hour shift is for charge-hands in those factories which have not enough men sufficiently trained to take alternate duty with the alien foremen instructors. In other factories, the unskilled hand works on a twelve-hour shift at his own wish. In 1929, however, following a conference between the Ministry of Labour, the Ministry of Agriculture and Fisheries and the Beet Sugar Factories Committee, a definite move was made to place all factories, from the year 1930, on the eight-hour basis, and this may now be regarded as the general practice among beet sugar factories in this country.

The eight-hour shift system is usually worked as follows: –The first shift from 6:00 a.m. to 2:00 p.m., the 2nd shift from 2:00 p.m. to 10:00 p.m. and the third shift from 10:00 p.m. to 6:00 a.m. As each shift worker is on duty seven days a week, his average working week is of 56 hours. The shifts are changed over at the weekend, generally each week. At the change of the shift, it is usual for 2 shifts to work 12 hours, leaving an 8-hours' additional rest to the third shift, or a rest period of 24 hours in all.

Day Workers. Day workers are those workers who are not included in the shift system of the factory but receive an agreed hourly rate for a regular working day, with special rates for overtime. They are principally men engaged in the workshops, stores, tare houses and beet laboratories, at the weighbridges, and in loading and unloading. The number of day workers employed by the beet sugar factories in the 1928 to 1929 campaign was 648, and in 1929 to 1930, 684.

The average number of hours per week, including overtime, worked by day workers at all the factories in the 1928 to 1929 campaign was 67 for general labourers, 69, for fitters and welders, 64 for turners and blacksmiths, 69 for crane drivers, 65 for stokers and 66 for electricians. In the off-season, the working week is shorter, the average in all cases being 46 hours.

The average number of hours worked per week by day workers during refining operations was 52 for general labourers, 50 for fitters and welders, 50 for turners and blacksmiths, 58 for crane drivers, 46 for stokers and 49 for electricians.

Additional Pay for Overtime and Sunday Work. During manufacturing seasons, only 6 factories have paid more than the ordinary rates per hour for overtime on weekdays. Three factories paid “time-and-a-half,” and three others paid “time-and-a-quarter” for the first two hours and “time-and-a-half” for further hours. In some cases, though ordinary rates were paid for general labourers, “time-and-a-half” was paid for certain classes of tradesmen. For Sunday

work, some factories paid ordinary rates, some paid “time-and-a-half”, and others double time. Statutory holidays are treated as Sundays and the practice with regard to Sunday pay has therefore been adopted on these days. A gratuity is given in addition at some factories to the campaign hands who work on Christmas Day.

Bonus on Production. Most of the British factories customarily pay their workers a bonus on results in addition to their wages. In most cases the bonus varies according to the production during each shift, in some cases to the tonnage of beets worked, in others to the output of sugar. In others it is a percentage upon the wages paid, if in the opinion of the directors, the results warrant it. In some cases, the bonus is paid only to workers engaged in the manufacturing processes; in others, to all employees except piece workers. When the bonus is based on sugar produced, the scale of payment is sometimes varied according to the average sugar content of the beets worked. It is impossible to accurately calculate the average additional earnings per man in the form of bonus. During one campaign, the bonus yield at one factory was 4 shillings and 8 pence per man per week; at another, 12 shillings and threepence per man per week.

Advantages in Kind. Apart from remuneration in the form of wages, salaries and bonuses, beet sugar factory workers also receive a number of advantages or services, all of which constitute additions to “real wages.” Thus, the general staff and the permanent factory workers in the off-season normally receive holiday leave, varying from a week to a month with pay. In some cases, the whole or part of the cost of travelling to and from the factory from the nearest town or village is defrayed by the factory, or special arrangements for reduced fares and special services are made by the factory with railway or omnibus companies. The provision by the factory of housing accommodation for the principal members of the general staff, for certain technical officers and sometimes for ordinary workers at nominal or low charges, is also a feature of the sugar beet industry in this country. Various welfare facilities are also provided for workers by the majority of factories. These include sports clubs and grounds, equipment, and accommodation and equipment for indoor amusements.

Meals and Refreshments. In a beet sugar factory, working continuously in shifts, the question of meals and refreshments is important. Theoretically, no man on shift can leave his post. This applies also to a certain number of day workers. In most of the British factories, there is no break for meals. Refreshments are carried round several times during each shift, practically all the factories providing a canteen for this purpose. Where a break for meals is permitted, the relay system applies, each man being allowed from 20 minutes to 3/4 of an hour for lunch, and a half hour for tea. Where a 12-hour shift is worked, one hour is allowed for dinner, with a short break in the morning and again in the afternoon. The day workers usually have fixed meal-times. The canteens are open day and night during the campaign, and hot water is always available. The men can purchase their meals from the canteens or bring them in their baskets for heating. The canteens are provided either by the factory or by caterers on contract. They are sometimes associated with the factory Sports Club, in which case they are run by the men, any profit accruing to the Sports Fund. Even then, the canteen is the property of the factory and is controlled by the factory during the campaign. The canteen is never, when owned by the factory, used as a profit-making concern, the prices being always as low as possible.

Washing Facilities, etc. Washing accommodation, with hot and cold water laid on, is generally provided, and in some cases shower-baths are also available. Accommodation is

usually provided for the workers' clothing, and at some factories there are separate lockers for each man. Rubber boots and waterproofs are supplied to workers exposed to wet. In some cases, huts with fires are provided for outside men. First aid appliances are provided at all factories, and in some there is an ambulance room in charge of a trained attendant.

Ownership and Organisation of British Beet Sugar Factories, 1930.

Group.	Name of Company.	Location of Factory.	Date of Registration.
Anglo-Dutch Group.	The English Beet Sugar Corporation Limited.	Cantley.	March the 29 th , 1929.
	Home Grown Sugar Limited	Kelham.	February the 13 th , 1920.
	The Ely Beet Sugar Factory, Limited.	Ely.	October the 20 th , 1924.
	The Ipswich Beet Sugar Factory, Limited.	Ipswich.	December the 29 th , 1924.
Anglo-Scottish Group.	The Kings Lynn Beet Sugar Factory, Limited.	Kings Lynn.	February the 2 nd , 1927.
	The Anglo-Scottish Beet Sugar Corporation, Limited.	Colwick and Spalding	January the 31 st , 1924.
	The West Midland Sugar Company, Limited.	Kidderminster.	December the 2 nd , 1924.
	Second Anglo-Scottish Beet Sugar Corporation, Limited.	Cupar, Felstead and Poppleton.	October the 1 st , 1925.
Bury Group.	The United Sugar Company, Limited.	Bury Saint Edmunds.	January the 15 th , 1925.
	The Central Sugar Company, Limited.	Peterborough.	November the 14 th , 1925.
	The Yorkshire Sugar Company, Limited.	Selby.	February the 28 th , 1927.
	Shropshire Beet Sugar Company, Limited.	Allscott.	April the 7 th , 1927.
Lincolnshire Group.	The Lincolnshire Sugar Company, Limited.	Bardney.	January the 19 th , 1927.
	Second Lincolnshire Sugar Company, Limited.	Brigg.	February the 16 th , 1928.
Wissington.	British Sugar Manufacturers, Limited.	Wissington.	April the 6 th , 1925.

Capacity of Factories. The average daily capacity of beet sugar factories varies considerably from one country to another. In Belgium, the average is 700 tons of beet per day, in Czechoslovakia, 1,000 tons, in France, 800 tons, in Germany 800 tons, in the Netherlands 2,000 tons and in the United States 1,000 tons.

In the two last-named countries, the factories are grouped under central or district control, which has permitted the concentration of manufacture in fewer and larger units.

When the Kelham factory was built in 1921, it was the opinion of the French experts consulted, that factories of from 500 to 600 tons capacity per day were the most satisfactory from every standpoint. Such factories might be built relatively close together, and transport might thus be saved.

Moreover, there would be a smaller capital outlay at risk in the event of a small acreage or short crop. In Great Britain, the newer factories have been built with a capacity of 1,000 tons and over, and that practically all the British factories have been materially increased in capacity since their erection, so that, in the 1930 campaign, only two factories were of less than 1,000 tons capacity.

The average capacity of factories in Great Britain is now over 1,300 tons, the smallest being 700 tons, and the largest 2,500 tons per day. British factories are thus, on the average, of greater capacity than the general run of factories in other European countries except the Netherlands. In the United States, large factories are the rule.

The Capacity of British Beet Sugar Factories per Day of 24 Hours on Erection, and in the 1930 to 1931 Campaign, are listed below.

Year of Erection.	Factory.	County.	Original Capacity.	Capacity 1930-31 Campaign.	Increase to date.
			Tons.	Tons.	Tons.
1912	Cantley	Norfolk	800	2,500	1,700
1921	Kelham	Nottingham	500	1,000	500
1924	Colwick	Nottingham	500	1,200	700
1925	Bury Saint Edmunds	Suffolk	1,000	2,000	1,000
1925	Ely	Isle of Ely	1,200	2,500	1,300
1925	Greenock	Renfrew	500	----	500
1925	Ipswich	Suffolk	1,200	1,450	250
1925	Kidderminster	Worcester	500	1,200	700
1925	Spalding	Lincoln	500	1,200	700
1925	Wissington	Norfolk	600	1,000	400
1926	Cupar	Fife	500	1,200	700
1926	Felstead	Essex	500	1,200	700
1926	Peterborough	Soke of Peterborough. (Northampton)	700	1,800	1,100
1926	Poppleton	York	1,000	1,200	200
1927	Allscott	Salop	800	850	50
1927	Bardney	Lincoln	1,000	1,000	---
1927	Kings Lynn	Norfolk	1,200	1,200	---
1927	Selby	York	700	1,000	300
1928	Brigg	Lincoln	700	700	---
			14,400	24,200	9,800

Greenock closed after the 1927 season.

Sources of Plant and Machinery. Prior to the passing of the British Sugar (Subsidy) Act, 1925, factories were free to purchase their machinery in the world market, and the cheapest market was, generally speaking, found in foreign countries. Engineering firms abroad were accustomed to the manufacture of this class of machinery, although British manufacturers were acknowledged experts in the manufacture of cane sugar machinery and had a large export trade with tropical countries. The Cantley factory purchases machinery in the Netherlands and Germany. The Kelham factory in France and Germany whilst the Colwick factory was mainly furnished with British machinery, supplemented with some Belgian and German. The British Sugar (Subsidy) Act, 1925, (Section 1, 2b however, stipulated, as a condition of the payment of subsidy, that new factories built after the date of the Act, and existing factories must, in respect of plant and machinery installed on or after such a date, purchase at least 75 percent in this country, the Minister of Agriculture having powers to grant dispensation for any special reason. This dispensation was exercised only in respect of the Ely and Ipswich factories, since the machinery contracts for these factories had been placed before the Subsidy Act was passed; The dispensation applied to less than half of the machinery, in each case, of which a part was drawn from Dutch factories following the consolidation of the industry in the Netherlands. In the case of beet sugar factories erected with assistance under the Trades Facilities Acts, the whole of the plant and machinery, as defined in the relative section in the Subsidy Act, was required to be of British manufacture. These important stipulations were designed to promote as much employment as possible in this country in the erection of beet sugar factories.

It is probably true that the capital cost of factories has been higher than it would otherwise have been by reason of this stipulation. The fact that 25 percent of the machinery could be purchased abroad has to some extent assisted the factories to place their contracts for machinery at competitive prices, while British machinery manufacturers also competed with one another during the years when the factory development was at its peak.

Beet Sugar Factory Effluents. In this country, as abroad, industries requiring large quantities of water and using rivers and streams as a convenient source of supply, as well as a ready means of disposal of their waste waters or effluents, have developed faster than the machinery for protecting waterways from contamination. English law definitely makes provision against

wilful pollution; but the authorities responsible for setting the law in motion for the protection of freshwater fisheries have, in many places taken the view that "the stream is for industry and not for the fisher", and have not been inclined to take action unless the state of the stream was such as to become a public nuisance.

A factory in this country uses from 2 1/2 to 4 million gallons of water per 24 hours, of which about one-fifth is used in the diffusion process. This emerges as effluent, partly in the form of "process water" from the diffusion batteries and the pulp-presses, partly in the form of "condenser water" from the evaporation process. The remaining four-fifths is used as (1), for transporting the beets along the flumes and for washing the beets called "wash water", and (2), for pumping the lime cake from the filter presses and into the lime pits, --known as "lime sludge water", --. about 60,000 gallons of water per day are used for this latter purpose.

The "wash water" contains soil and particles of vegetable matter. The most dangerous effluent, however, is the process water. This contains, in suspension, vegetable matter such as particles of pulp, as well as organic matter in true and in colloidal solution, --such as sugars, gums, pectin's, celluloses, (which themselves are not toxic), and "saponin", a toxic substance which issues from the skin of the beet and is poisonous to fish if the waters are not sufficiently diluted. Any vegetable matter remaining in the water when it is returned to the river sets up fermentation and promotes the growth of bacteria and fungi. Oxygen is thus abstracted from the water, causing the fish in the river to be suffocated.

The "condenser water", though denuded of free oxygen, is comparatively free from polluting matter, but being warm, if mixed with other effluents, hastens the putrefaction of vegetable matter.

The "lime sludge" water is not so dangerous as "process water", but contains, in solution, matter which is apt to ferment, one of the fermentation products being sulphuretted hydrogen, which is also poisonous to fish. In fact, the addition of impure calcium carbonate in the lime sludge water to the other waters may be advantageous, as the colloidal matter is precipitated and the fermentation acids are neutralised.

Considerable attention has been drawn to the pollution of rivers by beet sugar factories in this country. When the factories were built, settling ponds, similar to those on the Continent, were installed at each factory with a view to the precipitation of solids from the effluent. The factory companies state that, in all, an expenditure of £120,000 was incurred in this direction, and that, as experience increased, a further £156,000 was spent on modifications and improvements of the purifying system. Moreover, for the manufacturing season of 1930, a further expenditure of £65,000 is stated to have been incurred, making an expenditure of £341,000 in all for the purpose of purifying effluents.

Notwithstanding these precautions, pollution of rivers by beet sugar factory effluents has from time to time taken place. There has been, however, a fairly general disinclination to set the law in motion against offending factories. Nobody wished to interfere with an industry new to the country and of great potential value to agriculture. The strict enforcement of the law would have brought most of the factories to a standstill: moreover, there appeared to be no obvious method of definitely avoiding pollution.

Attention was therefore concentrated on research directed towards the elimination of the trouble, and the Government, anxious on the one hand that the law against pollution should

be strictly enforced, and, on the other, that production of beet sugar should not be hampered, undertook through the Department of Scientific and Industrial Research, under the supervision of the Water Pollution Research Board, the investigation of means for dealing effectively with the problem. When research at home and abroad showed promise of success, pressure began to be applied to the manufacturers and in five cases, in respect of offences in the 1929 season, proceedings were taken by the authorities concerned under the Salmon and Freshwater Fisheries Act 1923. The manufacturers urged that the season was one of exceptional drought, as a result of which, the dilution of effluent by the river water had not taken place to the normal extent.

In the report of the Ministry of Agriculture and Fisheries on Salmon and Freshwater Fisheries for 1925 to 1928, it was stated that, in view of the damage caused by a number of beet sugar factories, information on the disposal of waste waters had been collected from all sugar beet-growing countries and placed at the disposal of the factories. A meeting subsequently took place between the representatives of the factories, the Ministry of Health and the Ministry of Agriculture and Fisheries, as a result of which, the factories engaged a specialist to advise their Effluent Research Committee as to the measures necessary. His report, suggested research into the use of biological filters, and led to experiments on these lines being conducted at the Rothamsted Experimental Station in 1927, with the aid of a grant from the Department of Scientific and Industrial Research. Following on this work, 2 biological filters were erected in June, 1927, at the Colwick factory for further experimental work under the direction of the Water Pollution Research Board.

In the annual report of the Water Pollution Research Board, 1928 to 1929, on this work, it is stated that a purity of from 70% to 80% was obtained in 1927 to 1928, which was improved to 90% in the following year, by treating the mixture of "process water" and "wash water" in biological filters, but it was considered that with a longer campaign, the deposition of solid matter in the filters would have been sufficient to put them out of action. A further trial was arranged in the 1929 to 1930 season on modified lines, the Beet Sugar Factories Committee, contributing to the cost of the experiment, as in previous years.

In January 1930, the Standing Committee on River Pollution, appointed by the Minister of Agriculture and Fisheries in 1921, issued its fourth report. In this report, the following statement, which had been endorsed by the Water Pollution Research Board, is made: - It has been one of our objects throughout our terms of office to seek the cooperation of potential polluters in the endeavour to avoid or remove pollution, and we have advocated the use of persuasion rather than recourse to litigation. The beet-sugar industry has, however, provided a pregnant illustration of the useful stimulus that may be given by legal compulsion. We have observed that the discovery of a simple and practical method of preventing pollution by a beet-sugar factory, followed promptly upon an Order of the Court resulting from proceedings taken by the County Councils. We now know that "wash water" can be re-used throughout a "campaign", and the occasion for its discharge into the river is thus avoided. We feel that the evidence of the experience of the factory in question, coupled with the information furnished by the experiments of the Water Pollution Research Board at Colwick regarding the practicability of treating "process water" by means of. Biological filters, has removed the last excuse for pollution by beet sugar factories.

Following this report, the Ministry of Agriculture and Fisheries intimated to the factory companies that, in its opinion, immediate steps should be taken by them to prevent pollution

resulting from the operation of any factory during the manufacturing season of 1930. The Beet Sugar Factories Committee had already sent to the Ministry of Agriculture and Fisheries and to the Water Pollution Research Board a complete statement by each factory showing the measures which were being taken to improve their methods as a result of the work of the Effluent Research Committee of the factories since its formation.

The views of the factory technologists constituting the Effluent Research Committee of the factories were as follows: –When the factories were built, the installation of “detritus” or sedimentation tanks or ponds in which the solids in suspension settled as the water passed from pond to pond was considered sufficient.

It was also thought necessary to mix all effluents so as to obtain the largest degree of dilution before reaching the river. Later, the effluent leaving the factory was screened to remove some of the fermentable matter with a view to minimising fermentation, and it was found advisable to keep separate the “lime sludge water,” withhold it from the river and discharge it onto the land. It was then found possible to recirculate the “wash water” provided it was not mixed with the “process water”.

The latter could not, however, be discharged into the river without special treatment. A few factories avoid the production of “process water” by the use of the Raabe or continuous process of diffusion, but this is considered objectionable at other factories on the ground that the non-sugars are retained in circulation with possible detriment to the crystallisation of the fresh juice, apart from the corrosion of pipelines, and the possibility of break-down in the manufacturing processes.

Towards the end of the previous year, (1929), the factory technical experts, after visits to those factories which had been testing certain improvements, made generally the following recommendations, which have been put into operation for the 1930 season and, in their opinion, based upon tests, constitute a definite advance in the solution of the problem.

- (a) The “wash water” with the flume and transport water to be kept separate and, after sedimentation on improved lines, re-circulated for use, thus reducing the volume of effluent to be ultimately discharged into the river.
- (b) The “condenser water” might be discharged directly into the river.
- (c) The “process waters” to be kept separate. The diffusion water to be re-circulated in the diffusion battery for flushing purposes only, thus reducing the volume of effluent.
- (d) The other “process water,” i.e., the “pulp press” water, to be used for mixing with the lime sludge and transporting it to special storage tanks. As the pits drain and the lime sludge dries, the liquid to be filtered in a special gravel filter, treated with ferrous sulphate and lime and after such purification, returned to the river.

The Committee was also not convinced from the experiments carried out at Rothamsted and Colwick that biological treatment was a practical proposition, and considered that, in any event, it would require to be on so large a scale as to be prohibitive in cost, and uneconomic in working.

The Cantley factory is, however, conducting an experiment in biological filtration following fermentation. More data may be available after the 1930 campaign to show whether the working costs of this scheme are less than those of the ordinary biological treatment.

APPENDIX E.
STATISTICS OF THROUGHPUT AND OUTPUT OF BRITISH BEET SUGAR FACTORIES. AVERAGE OF ALL
FACTORIES*, CAMPAIGNS 1924-5 to 1930-31.

	1924-5.	1925-6.	1926-7.	1927-8.	1928-9.	1929-30.	1930-31.
FACTORIES :							
(a) Number of Factories	3	9	14	18	18	18	18
(b) Length of Campaign Days	84	87	104	93	74	91	111
(c) Average Daily Rated Capacity per Factory ... Tons	916	917	839	1,094	1,105	1,167	1,344
SUGAR BEET :							
(d) Number of Growers per Factory	1,346	1,167	1,476	1,770	1,392	1,789	2,245
(e) Acreage per Factory Acres	7,546	6,249	9,247	12,940	9,891	12,808	10,384
(f) Average Tare per Cwt. lb.	16	17	17	20	23	13.5	15.0
(g) Average Net Yield per Acre Tons	8.10	7.67	8.63	6.45	7.69	8.69	8.77
(h) Average Throughput per Factory Tons	61,238	47,909	79,791	83,302	75,268	110,257	170,028
(i) Average Tonnage worked per Day Tons	729	551	767	896	1,017	1,212	1,532
(j) Percentage of Capacity per day Per cent.	80	60	91	82	92	104	114
(k) Average Price delivered to Factory Per ton	52s. 4d.	55s. 6d.	59s. 6d.	55s. 5d.	52s. 0d.	52s. 11d.	49s. 10d.
SUGAR :							
(l) Average Sugar-content in the Beets Per cent.	16.6	16.4	17.3	16.1	17.4	17.7	16.7
(m) Average Sucrose per Acre lb.	3,027	2,809	3,346	2,330	2,995	3,440	3,288
(n) Average Rate of Sugar Extraction Per cent.	13.0	12.0	13.7	12.6	14.1	14.4	13.7
(o) Average Commercial Sugar per Acre lb.	2,367	2,063	2,654	1,846	2,503	2,838	2,724
(p) White Sugar produced per Factory Tons	7,962	5,750	10,950	10,502	10,736	15,996	23,220
(q) Percentage of (p) to (l) Per cent.	78.2	73.4	79.9	78.5	82.0	82.5	82.0
(r) Average Gross Price realised on the Market cum duty ex Factory† Per cent.	32s. 8d.	26s. 6d.	30s. 1d.	28s. 9d.	23s. 4d.	20s. 8d.	—
MOLASSES :							
(s) Molasses Produced per Factory Tons	1,900	1,505	2,690	3,167	2,708	4,092	5,850†
(t) Average Production per ton of Beet Cwt.	0.62	0.63	0.69	0.76	0.72	0.74	0.7†
(u) Average Price ex Factory Per cwt.	6s. 4d.	2s. 6d.	1s. 7d.	1s. 6d.	2s. 5d.	2s. 0d.	—
PULP :							
(v) Pulp Produced per Factory Tons	2,946	2,671	4,533	4,792	4,674	6,419	9,778
(w) Average Production per ton of Beet Cwt.	1.0	1.1	1.1	1.1	1.2	1.2	1.2
(x) Average Price ex Factory Per ton	£4 3s. 11d.	£4 16s. 7d.	£4 1s. 8d.	£3 18s. 6d.	£4 19s. 6d.	£4 12s. 10d.	—

* Excludes Eynsham, 1927-30.

† Before deduction of selling expenses.

‡ Provisional.

Appendices.

APPENDIX F.—SUMMARY OF TRADING ACCOUNTS OF BRITISH BEET SUGAR FACTORIES.*
As furnished voluntarily and confidentially by the factories each year to the Ministry of Agriculture and Fisheries.

	1924-5.	1925-6.	1926-7.	1927-8.	1928-9.	1929-30.	TOTAL.
	£	£	£	INCOME.	£	£	£
Net Income from Sugar (less Excise Duty)	500,528	909,803	3,226,783	3,669,942	3,049,192	3,889,068	15,245,316
Molasses	30,322	34,073	50,080	85,583	118,245	149,942	478,145
Pulp	37,104	116,123	264,033	363,341	487,841	650,152	1,918,594
Lime Sludge	1,488	139	2,224	1,924	4,064	2,735	12,544
Total	569,412	1,060,138	3,553,020	4,120,790	3,659,342	4,691,897	17,654,599
Add Subsidy	500,651	1,120,263	3,338,350	4,152,408	2,823,740	4,191,847	16,127,259
Total Income	1,070,063	2,180,401	6,891,370	8,273,198	6,483,082	8,883,744	33,781,858
Trading Loss	—	110,390	31,259	—	—	—	141,649
Total	1,070,063	2,290,791	6,922,629	8,273,198	6,483,082	8,883,744	33,923,507
				EXPENDITURE.			
Coal and Coke	43,266	92,604	505,009	291,994	228,582	307,240	1,468,695
Limestone	7,258	21,197	50,191	69,152	52,927	64,561	265,287
Bags	18,772	49,733	124,324	147,109	154,045	189,922	683,905
Other Manufacturing Supplies	17,219	37,619	104,522	128,957	100,636	122,503	511,756
Repairs and Maintenance ...	43,170	64,014	127,202	272,181	173,199	166,957	846,723
Salaries and Wages	107,175	272,780	539,417	662,466	595,251	673,272	2,850,361
Rates and Insurance	11,388	27,711	57,229	91,210	81,080	71,958	340,576
Other General Charges	12,585	35,004	97,878	121,151	100,312	120,519	487,449
Costs of Beets	260,833	600,962	1,605,772	1,784,220	1,486,033	1,716,932	7,454,752
Beet Expenses	480,716	1,196,538	3,323,289	4,102,828	3,522,563	5,251,000	17,876,934
Total Expenditure	770,335	1,909,786	5,149,640	6,079,455	5,146,883	7,144,808	26,200,907
Trading Profit	299,728	381,005	1,772,989	2,193,743	1,336,199	1,738,936	7,722,600
Total	1,070,063	2,290,791	6,922,629	8,273,198	6,483,082	8,883,744	33,923,507

* Excluding figures for the factories at Greenock and Eynsham for the years 1927-28 to 1929-30.

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